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Title: XAPS Proton DRM Investigation

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XAPS Proton DRM Investigation

M. Carver

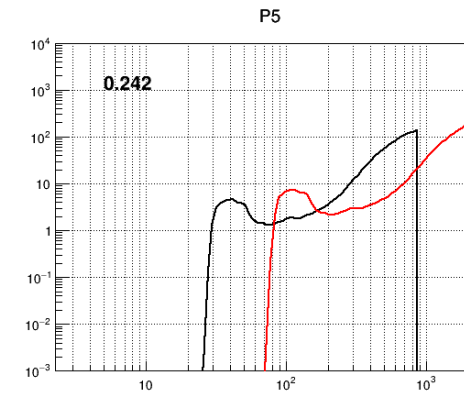
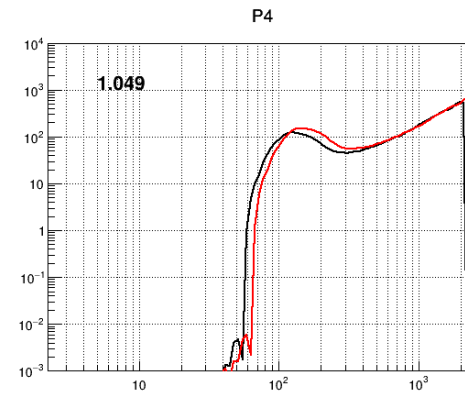
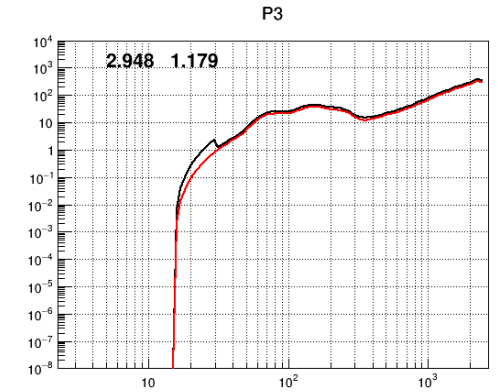
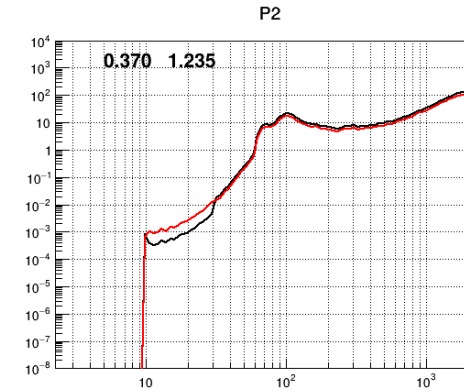
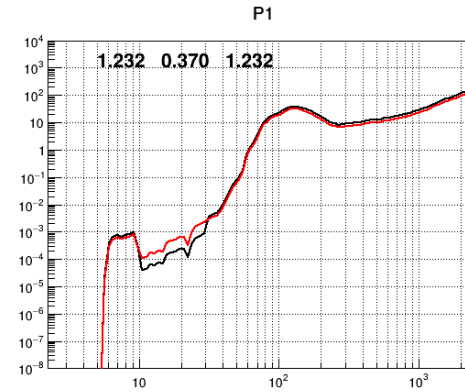
25 April 2022



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The Problem

- Comparing nominal and updated DRM post cross-calibration circa 2018 shows strange behavior
 - Shifted energy ranges
 - Non-consistent response factors
- P5 is most striking here, but as we'll see the problem is more widespread



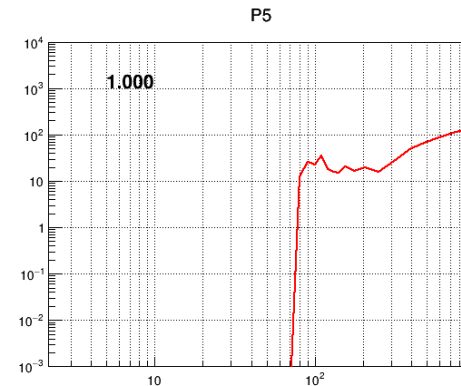
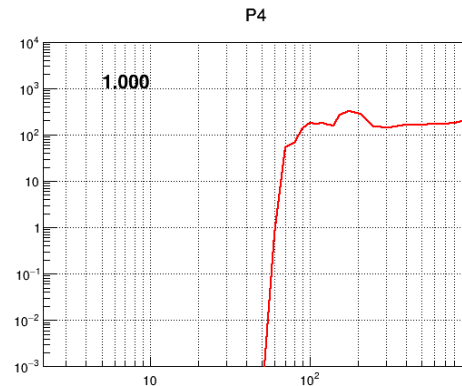
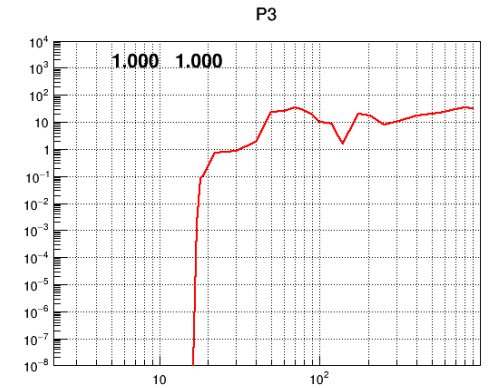
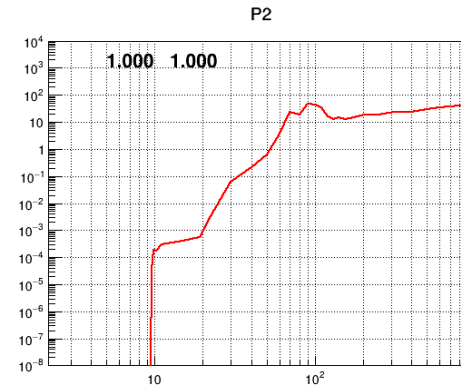
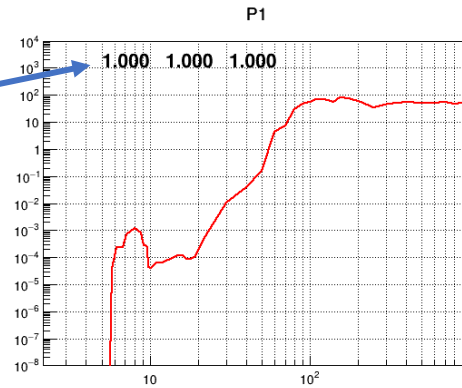
2018 Paper DRMs
Current DRMs

Nominal response_files/drm_2f_p_trial.dat

Updated response_files/drm_2f_SVN62.dat

DRM Comparisons - IIR

- Plots show each channel for SVN53 compared with the DRMs used in the 2018 paper
- Numbers on each plot correspond to the response factor applied to one of 3 energy ranges – should match numbers derived in cross-cal
 - < 10 MeV
 - 10 – 30 MeV
 - > 30 MeV
- All Block IIR DRMs are correct...mostly
 - P3 seems to be a copy of SVN54 for all other satellites > 54
 - Between 1% and 20% off from correct value



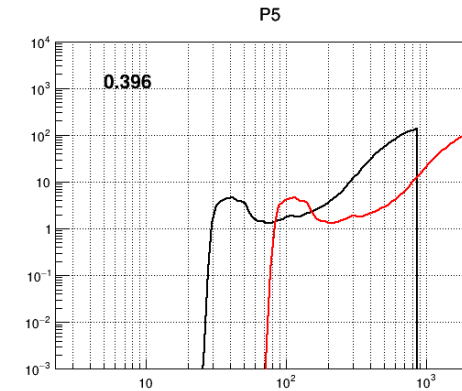
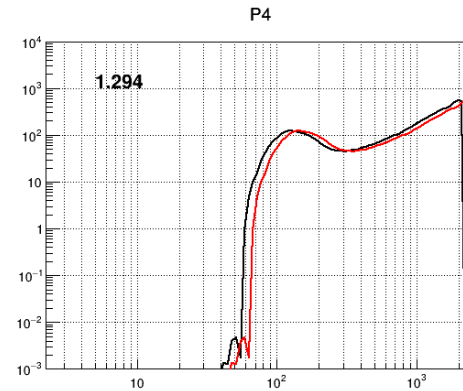
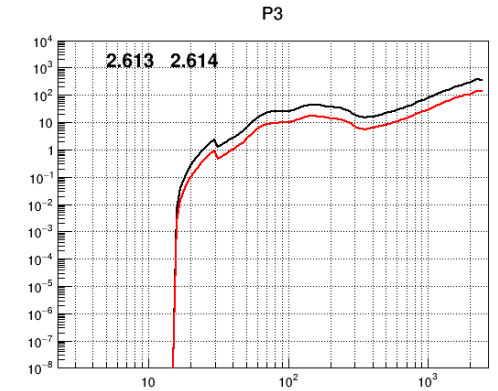
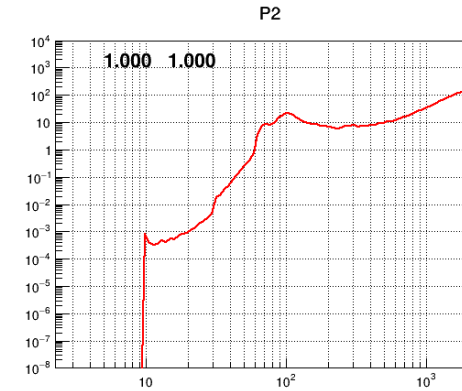
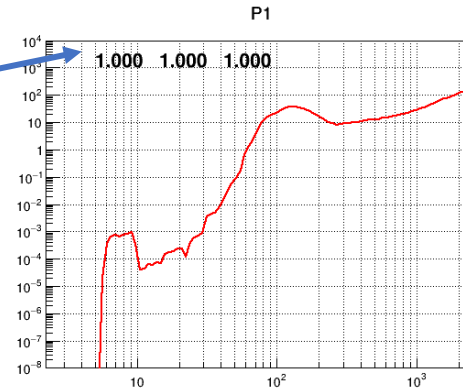
2018 Paper DRMs
Current DRMs

Nominal paper_drms/drm_2r_SVN53.dat

Updated response_files/drm_2r_SVN53.dat

DRM Comparisons - IIF

- Plots show each channel for SVN62 compared with the DRMs used in the 2018 paper
- Numbers on each plot correspond to the response factor applied to one of 3 energy ranges – should match numbers derived in cross-cal
 - < 10 MeV
 - 10 – 30 MeV
 - > 30 MeV
- All block IIF DRMs are right and wrong....
 - P1 and P2 are correct for all SVNs
 - P3 and P4 between 5% and factor of 2 off for all SVNs
 - P5 shifted lower in energy 20 – 30 MeV for all SVNs



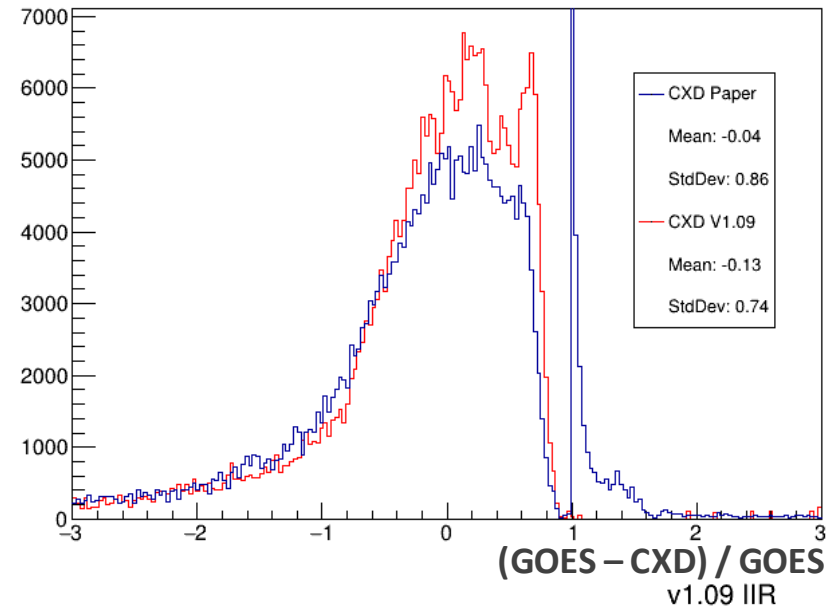
2018 Paper DRMs Current DRMs

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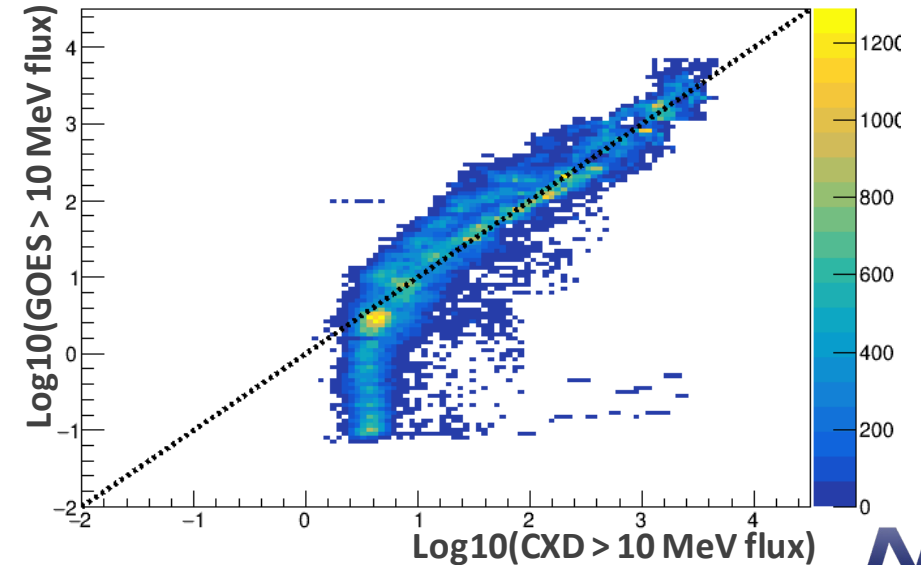
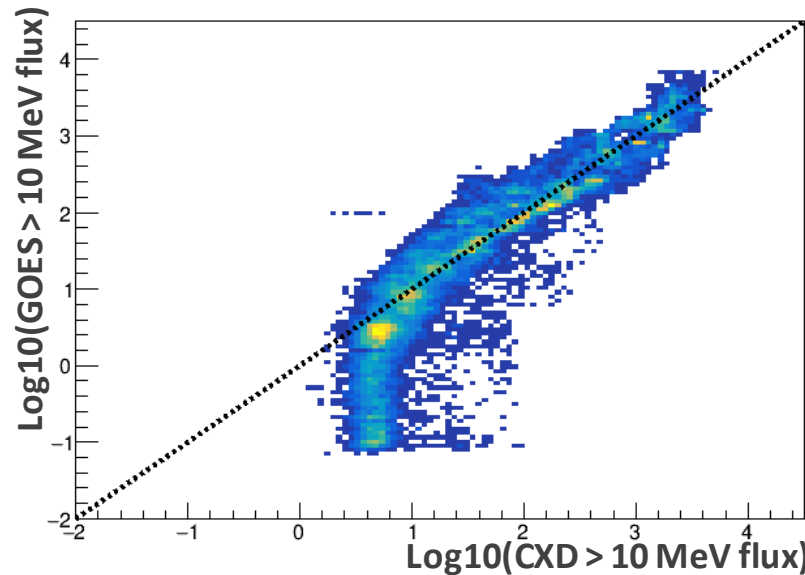
Updated response_files/drm_2f_SVN62.dat

Extent of the Damage – IIR > 10 MeV Flux

- V1.09 overall similar to the paper
- Peak and values ≥ 1 (negative CXD flux) for paper data should be investigated further
 - ❖ Seems like an artifact of background subtraction

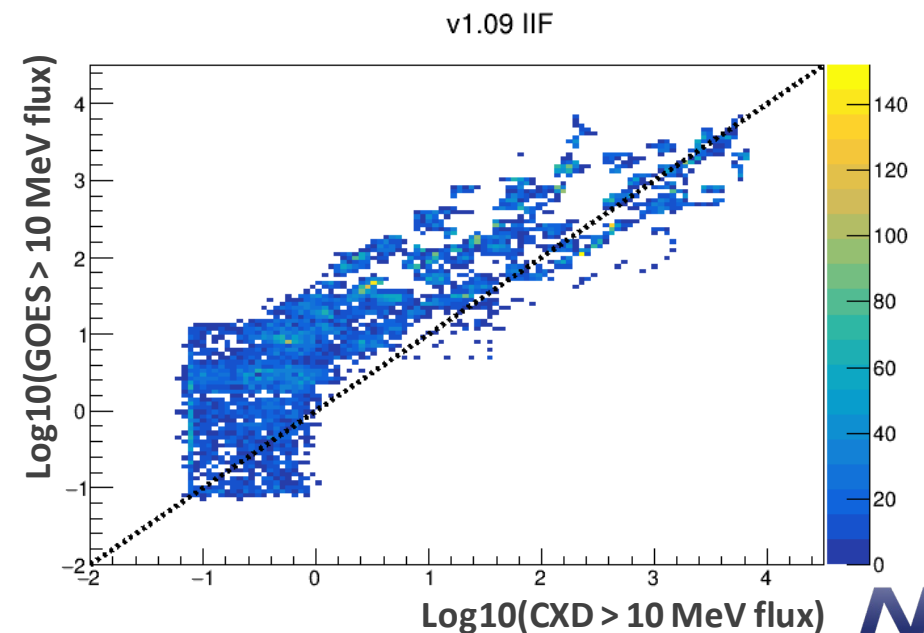
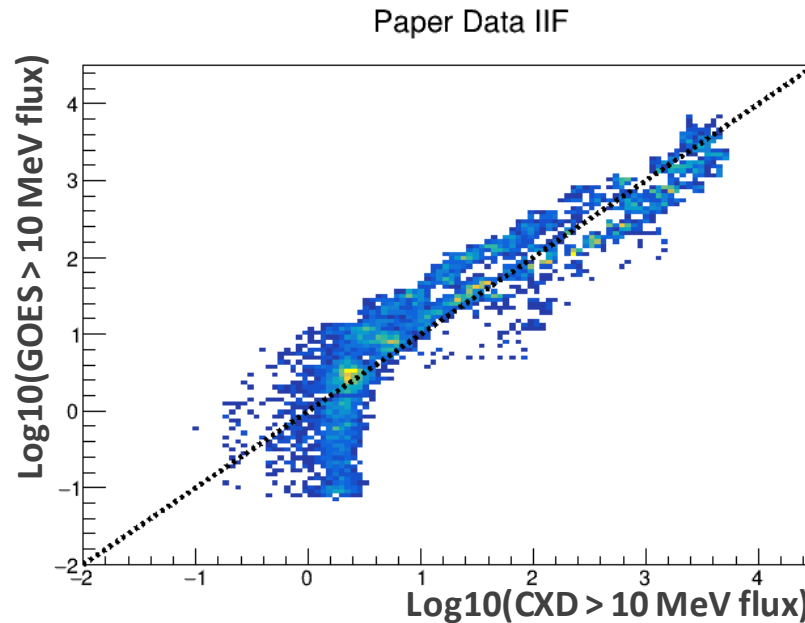
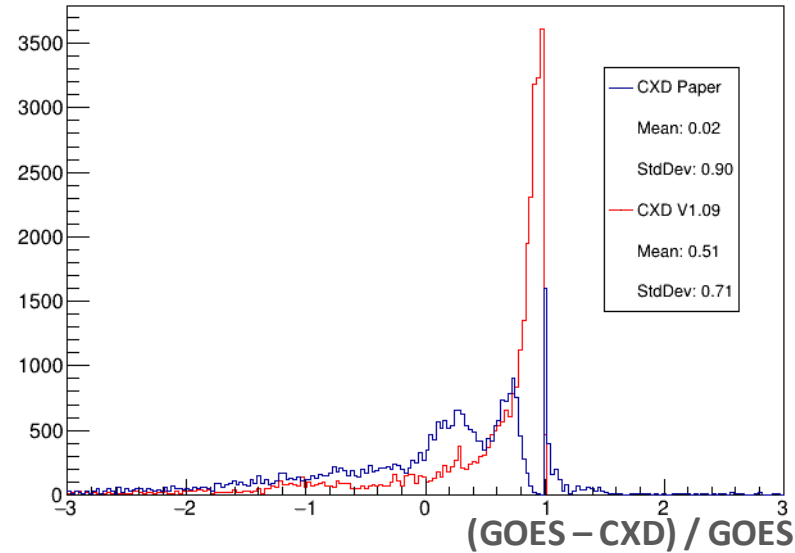


Paper Data IIR



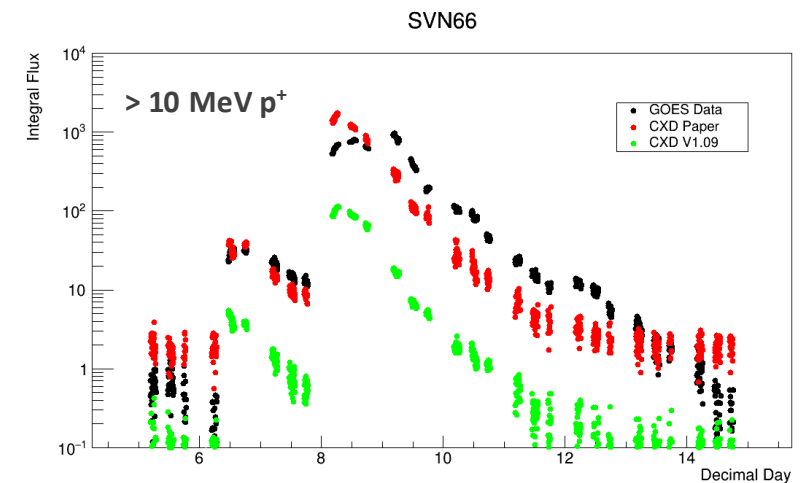
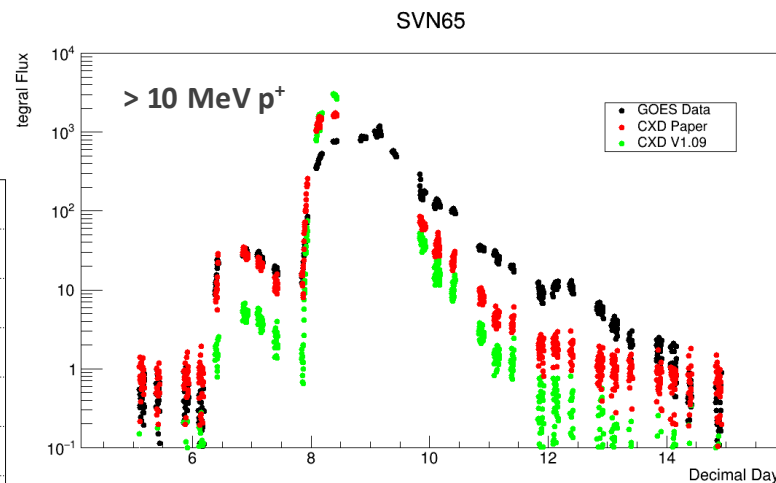
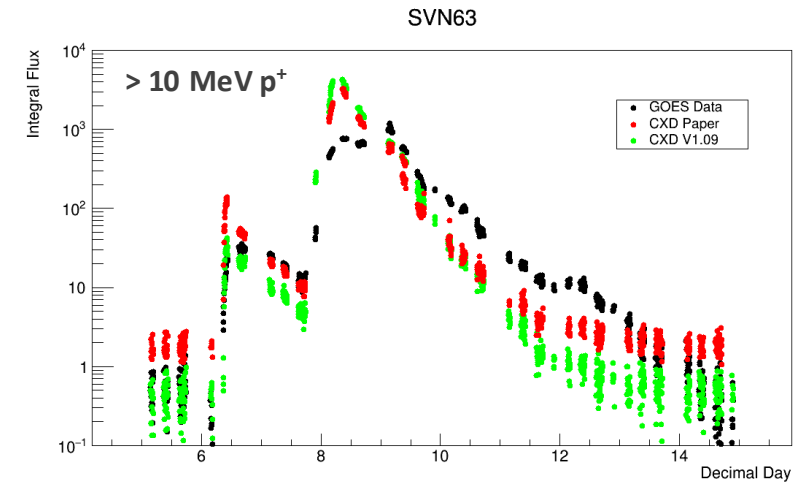
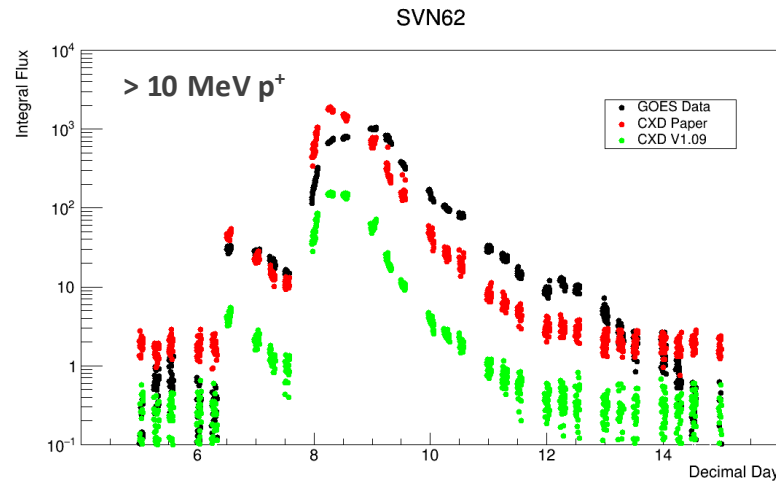
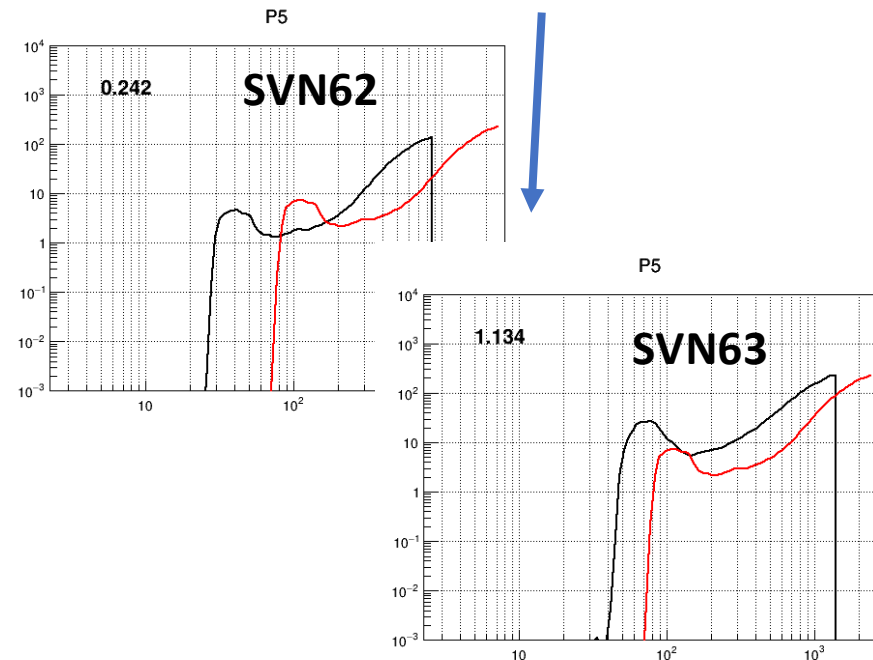
Extent of the Damage – IIF > 10 MeV Flux

- Significant deviation from the paper data with IIF
 - Shifted lower in flux
 - Consistent with larger response at lower energies in P5
- Peak at 1 with 2018 paper DRMs still present with IIF



Extent of the Damage – IIF > 10 MeV Flux Timeseries

- Only four IIF boxes were on orbit for the cross-cal – 62, 63, 65, and 66
- SVN62 and 66 show worse behavior than other two
 - Consistent with more P5 energy shifting than others



Extent of the Damage – IIF Flux Comparisons

- Trend continues across energy range we calculate
- SVN 62 and 66 ~3x worse on average
- SVN 63 and 66 ~50% worse on average

SVN Mean % Difference from GOES	> 10 MeV	> 30 MeV	> 60 MeV	> 100 MeV	Average across E
62 Paper	-1.2	-18.1	-57.4	-25.3	25.5
62 v1.09	90.5	67.8	-23.5	-111.9	73.4
63 Paper	-21.7	-12.4	-22.4	-31.1	21.9
63 v1.09	0.3	59.8	58.6	-20.5	34.8
65 Paper	37.7	43.6	48.3	-70.1	49.9
65 v1.09	55.5	79.5	85.3	-51	67.8
66 Paper	36.7	-5.1	-50.1	-23.7	28.9
66 v1.09	94.5	70.2	-25.7	-138.8	82.3

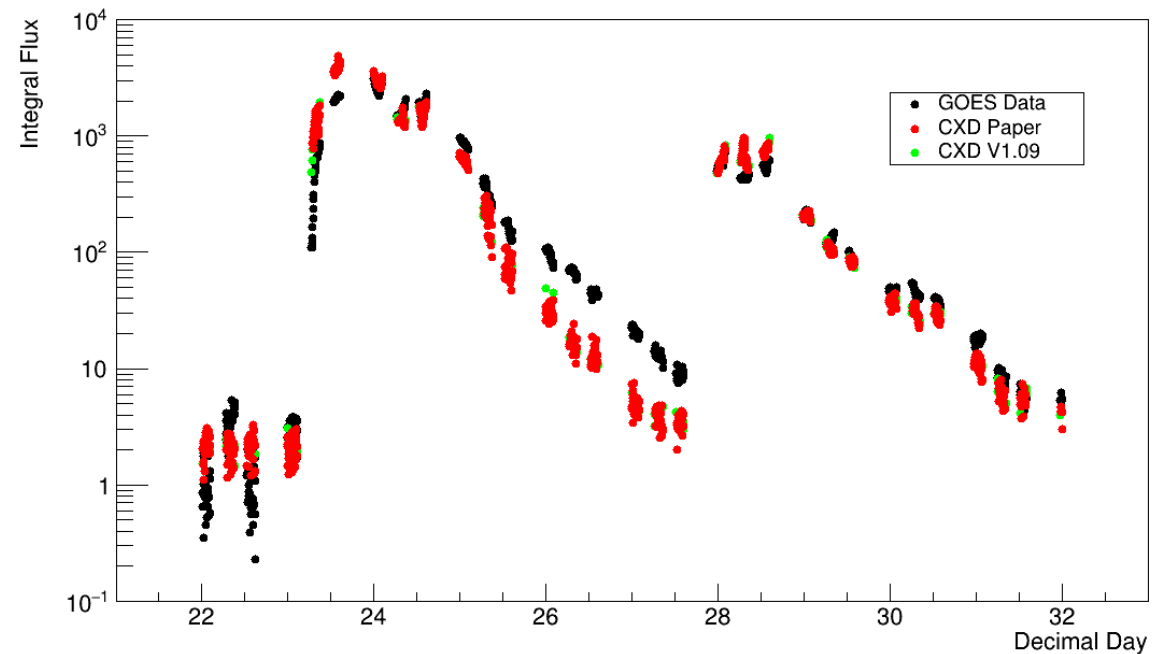
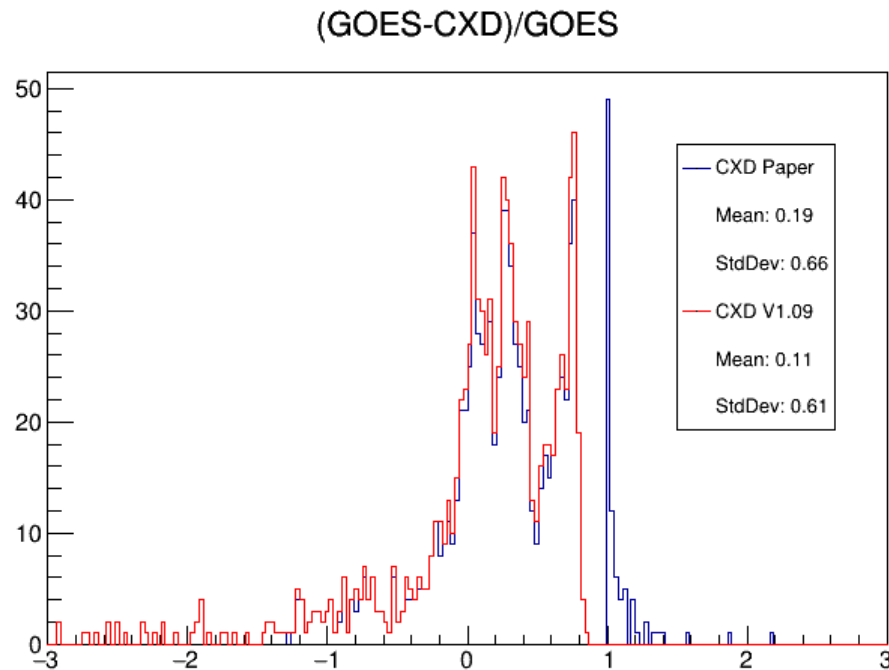
Extent of the Damage – IIF Flux Comparisons

- Trend continues across energy range we calculate
- SVN 62 and 66 ~3x worse on average
- SVN 63 and 66 ~50% worse on average
- A few outliers where v1.09 is 'better'

SVN Mean % Difference from GOES	> 10 MeV	> 30 MeV	> 60 MeV	> 100 MeV	Average across E
62 Paper	-1.2	-18.1	-57.4	-25.3	25.5
62 v1.09	90.5	67.8	-23.5	-111.9	73.4
63 Paper	-21.7	-12.4	-22.4	-31.1	21.9
63 v1.09	0.3	59.8	58.6	-20.5	34.8
65 Paper	37.7	43.6	48.3	-70.1	49.9
65 v1.09	55.5	79.5	85.3	-51	67.8
66 Paper	36.7	-5.1	-50.1	-23.7	28.9
66 v1.09	94.5	70.2	-25.7	-138.8	82.3

Extent of the Damage – SVN 62 Flux v1.08

- Interestingly, v1.08 does not show the same behavior
- Likely a result of my local running of v1.08 with DRMs not yet committed to a repository



Response Factor Inconsistencies

- Inconsistencies between response factors listed in 2018 paper and what was used in actual calculations
- SVNs 57, 61, 62, and 63 are different for channels P1 and P2

Table 2

List of Response Factors Applied to Each Channel per SVN

SVN	P1	P2	P3	P4	P5
53	1.719	1.419	1.361	1.627	2.101
54	1.918	1.619	1.179	1.669	2.207
55	1.648	1.262	1.156	1.582	1.784
56	1.792	1.524	1.170	1.520	1.779
57	1.686	1.429	0.970	1.519	1.247
58	1.859	1.566	1.256	1.821	2.124
59	1.752	1.417	1.160	1.487	1.606
60	2.101	1.776	1.149	1.631	1.989
61	1.880	1.478	1.063	1.422	1.551
62	1.478	1.482	0.451	0.811	0.611
63	1.462	1.114	0.591	1.110	0.472
64 ^a	1.460	1.348	0.624	0.714	0.556
65	1.460	1.348	0.624	0.714	0.556
66	1.335	1.251	0.453	0.710	0.751
67 ^a	1.460	1.348	0.624	0.714	0.556
68 ^a	1.460	1.348	0.624	0.714	0.556
69 ^b	1.335	1.251	0.453	0.710	0.751
70 ^a	1.460	1.348	0.624	0.714	0.556
71 ^a	1.460	1.348	0.624	0.714	0.556
72 ^a	1.460	1.348	0.624	0.714	0.556
73 ^b	1.335	1.251	0.453	0.710	0.751
Average IIR	1.817	1.499	1.163	1.586	1.821
Average IIF	1.430	1.315	0.549	0.812	0.602

Note. These numbers do not include the additional factor in the 10–30 MeV range to channels P1 (0.3), P2 (0.3), and P3 (2.5). SVN = space vehicle number.
^aA copy of SVN65. ^bA copy of SVN66.

make_new_proton_drms.sh 3.79 KB

```

1  #!/bin/bash
2
3  svn=(53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73)
4  #53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73)
5  chan=(12 13 14 15 16)
6  RF53=(1.71977 1.41951 1.13606 1.626764 2.10087 )
7  RF54=(1.91786 1.61854 1.17935 1.669176 2.20688 )
8  RF55=(1.64844 1.26228 1.15596 1.5824025 1.78357 )
9  RF56=(1.79179 1.524 1.17045 1.520352 1.77868 )
10 RF57=(1.46649 1.24299 0.970437 1.51906 1.24697 )
11 RF58=(1.85955 1.56631 1.256 1.8206751 2.12407 )
12 RF59=(1.75209 1.4168 1.16039 1.4872025 1.6063 )
13 RF60=(2.10139 1.77634 1.14948 1.631112 1.98918 )
14 RF61=(1.70919 1.34342 1.06252 1.4215315 1.55075 )
15 RF62=(1.23168 1.2348 0.451337 0.8109872 0.611162)
16 RF63=(1.27119 0.969102 0.59062 1.11023 0.471784)
17 RF64=(1.46016 1.34763 0.624248 0.510225 0.556068)
18 RF65=(1.46016 1.34763 0.624248 0.714315 0.556068)
19 RF66=(1.33483 1.25085 0.452771 0.7103964 0.75112 )
20 RF67=(1.46016 1.34763 0.624248 0.510225 0.556068)
21 RF68=(1.46016 1.34763 0.624248 0.510225 0.556068)
22 RF69=(1.33483 1.25085 0.452771 0.507426 0.75112 )
23 RF70=(1.46016 1.34763 0.624248 0.510225 0.556068)
24 RF71=(1.46016 1.34763 0.624248 0.510225 0.556068)
25 RF72=(1.46016 1.34763 0.624248 0.510225 0.556068)
26 RF73=(1.33483 1.25085 0.452771 0.507426 0.75112 )
27 outputdir="FinalDRMS"
28

```

Takeaways

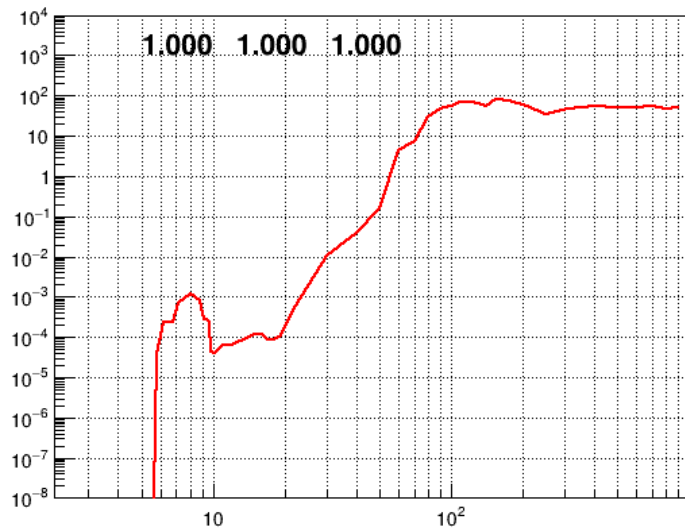
- The DRMs used for the v1.09 release were incorrect, more so for IIF than IIR
 - ❖ No significant difference in calculated flux for IIR boxes
 - ❖ IIF fluxes vary between 50% - 200% off from the original 2018 cross-cal paper
- The cause of DRM discrepancy is unclear – the automated script in the repo produces correct results
 - ❖ We have the correct DRMs, they just need to be committed to the repo
- This wasn't caught for the v1.09 release because all regression tests in the repo are currently checking for orders of magnitude difference in fit parameters – **this should be fixed, and other tests added**
- Also identified inconsistency with response factors listed in paper and used in DRMs – not sure how to go about fixing that. Maybe send an edit to Space Weather Journal?
- Need to notify potential users of data and stakeholders of the issue
 - Update the v1.09 README on the NOAA website until next release



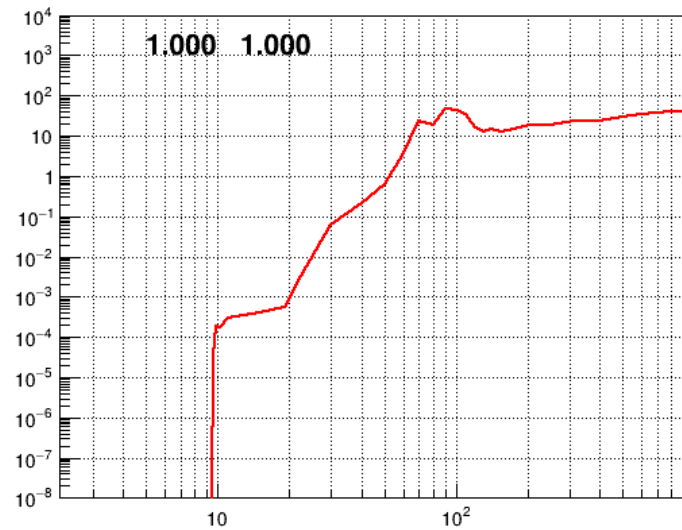
Backup



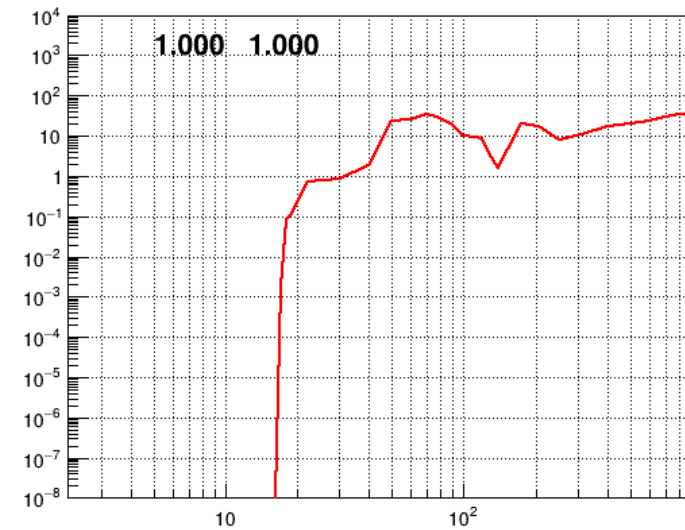
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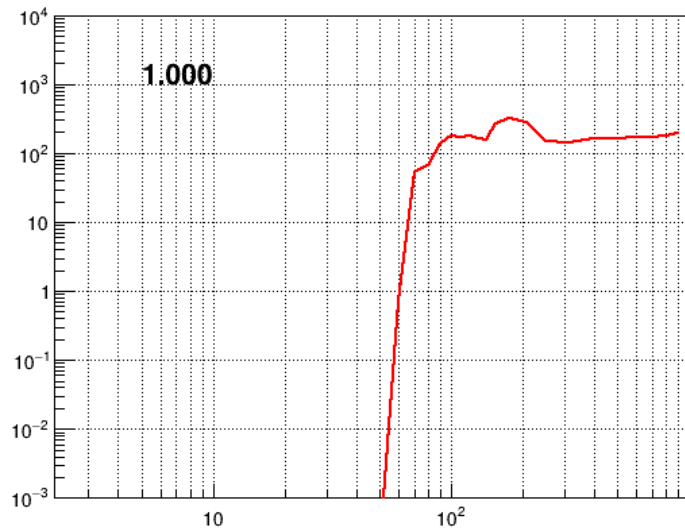
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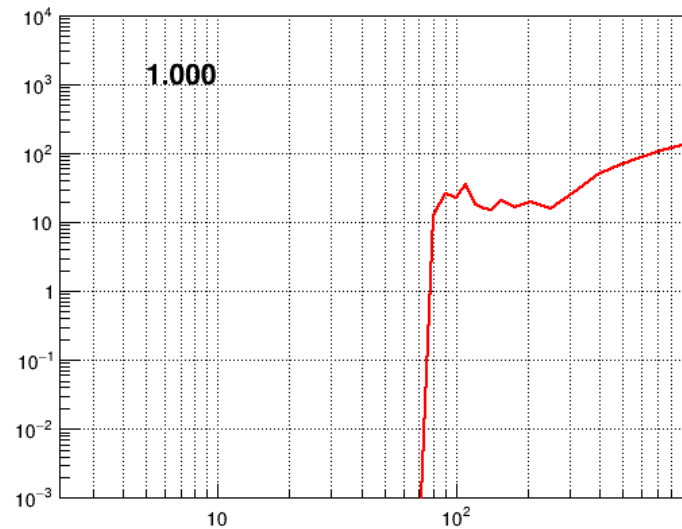
P3



P4



P5

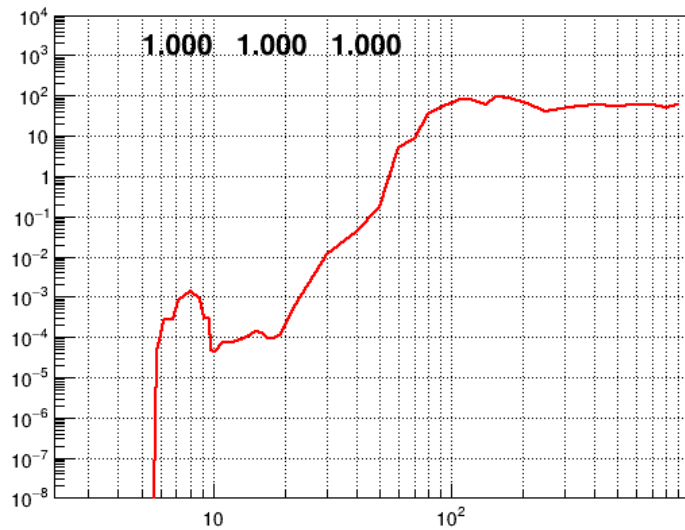


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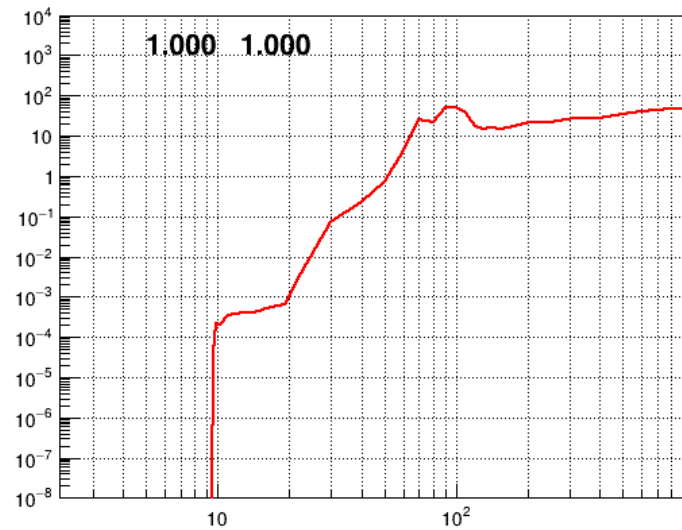
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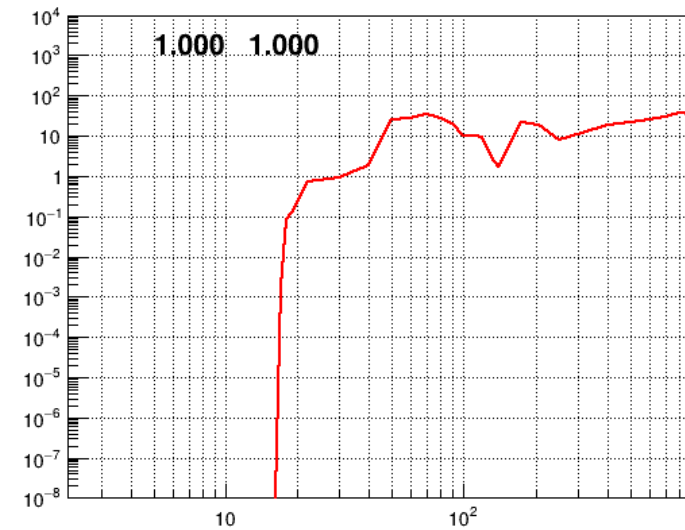
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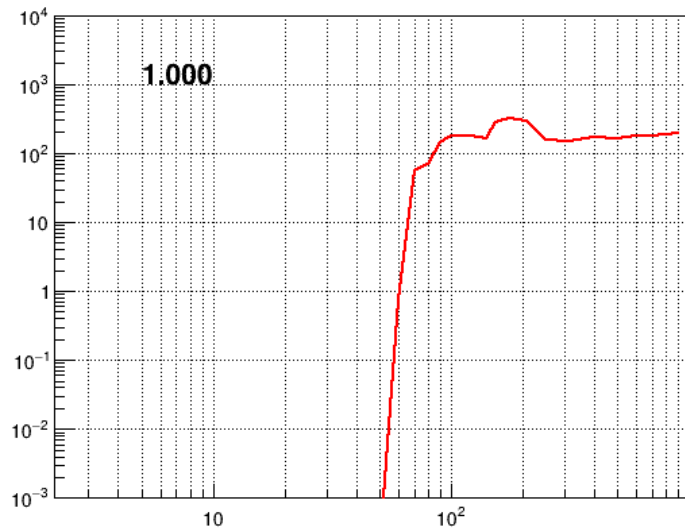
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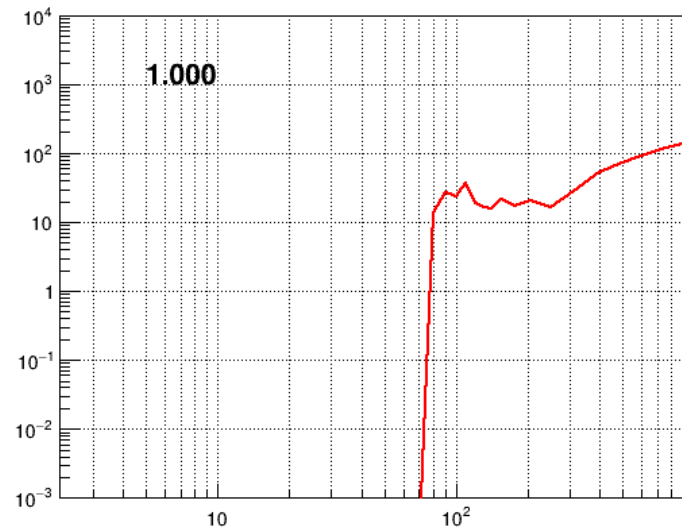
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P4



P5

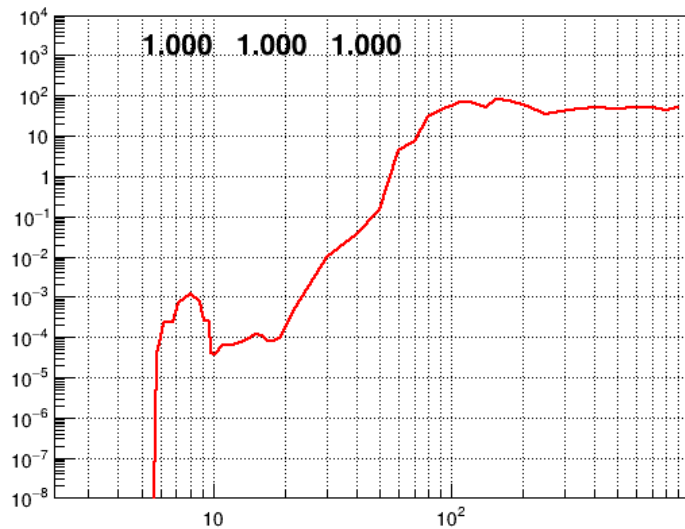


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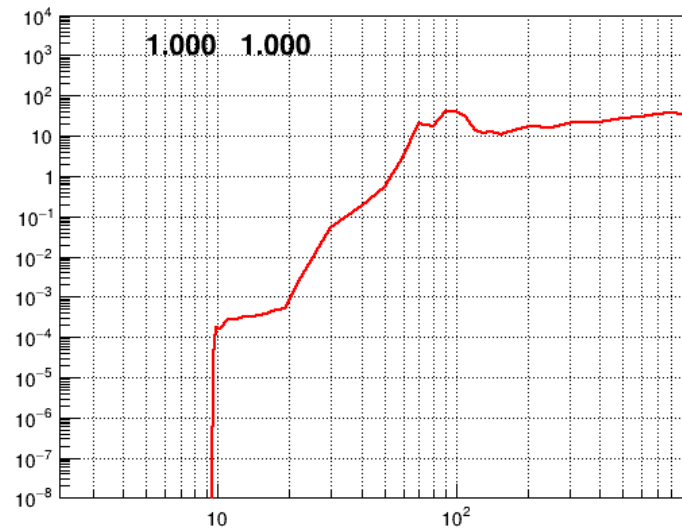
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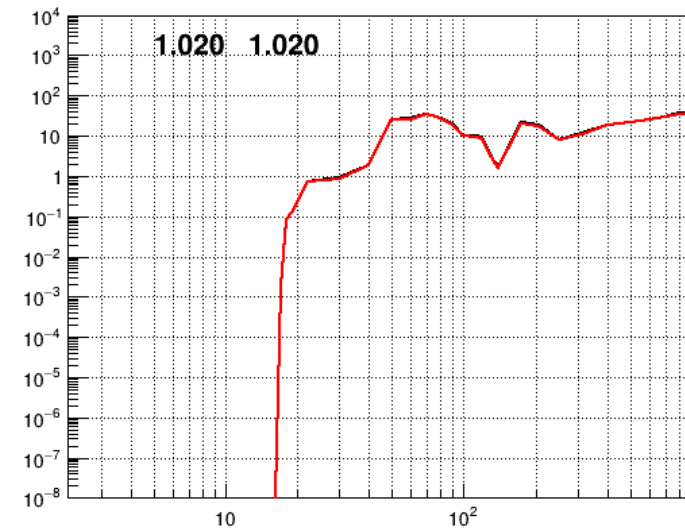
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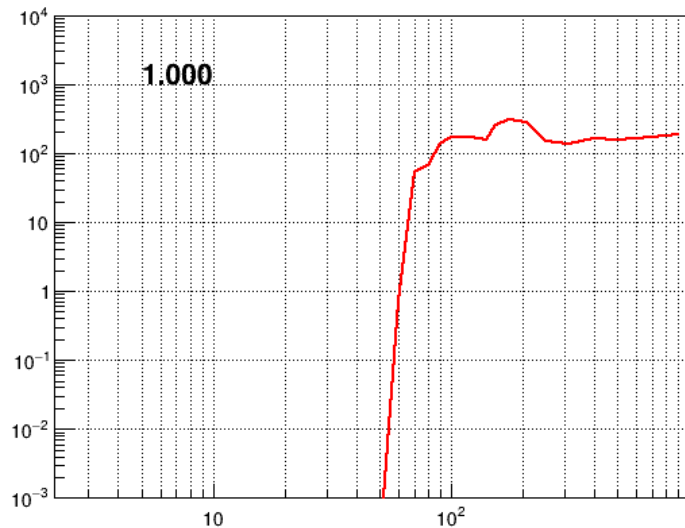
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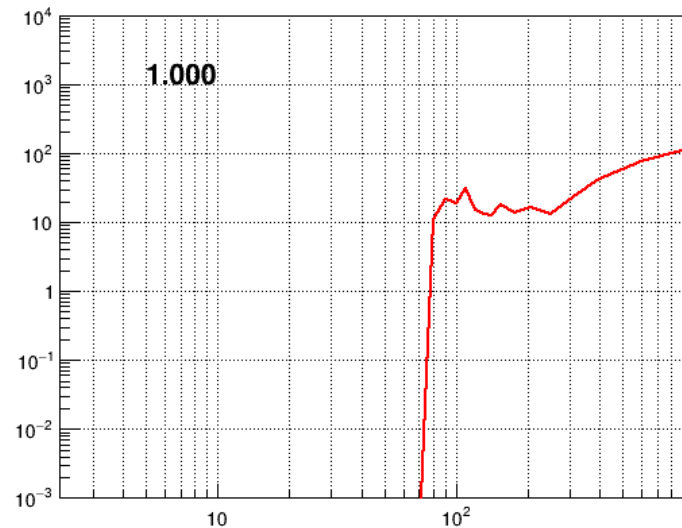
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P4



P5

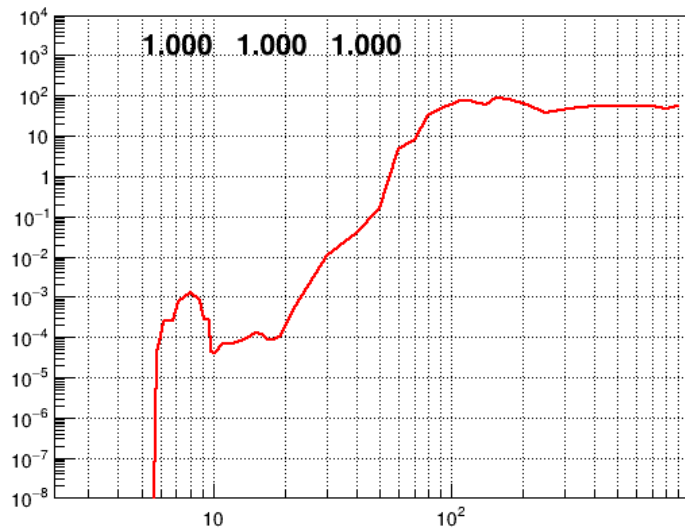


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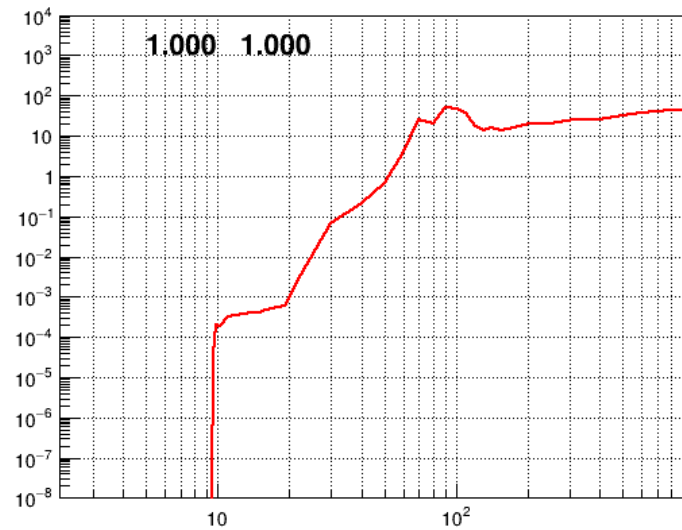
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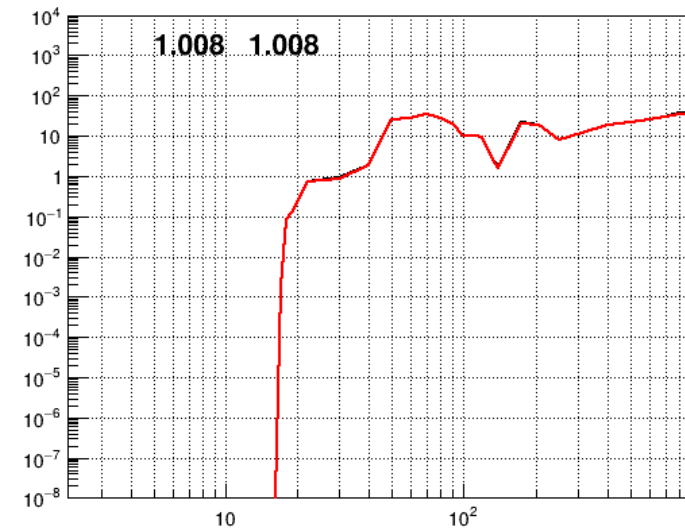
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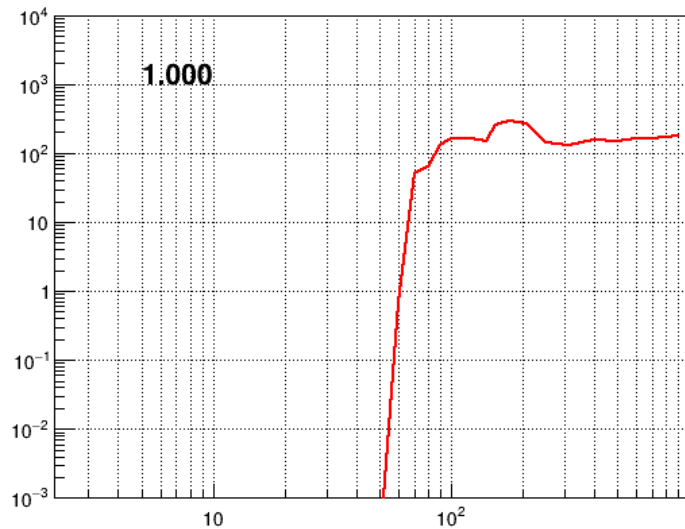
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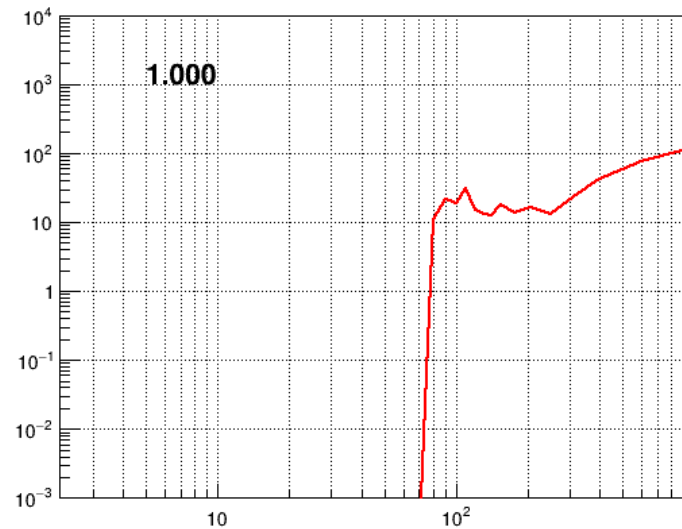
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P4



P5

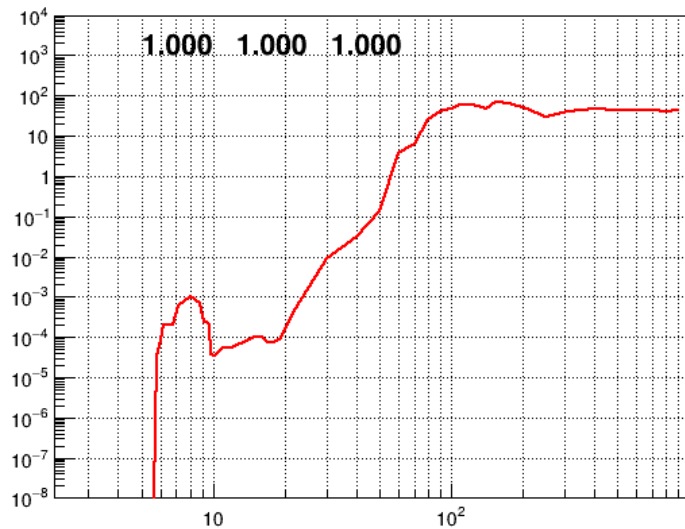


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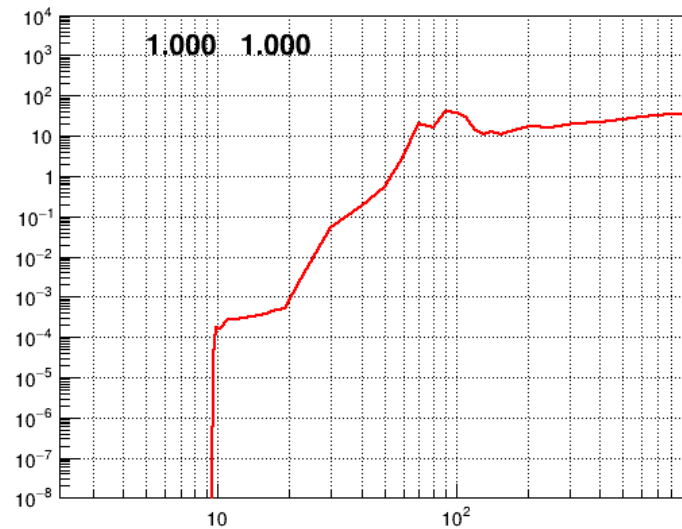
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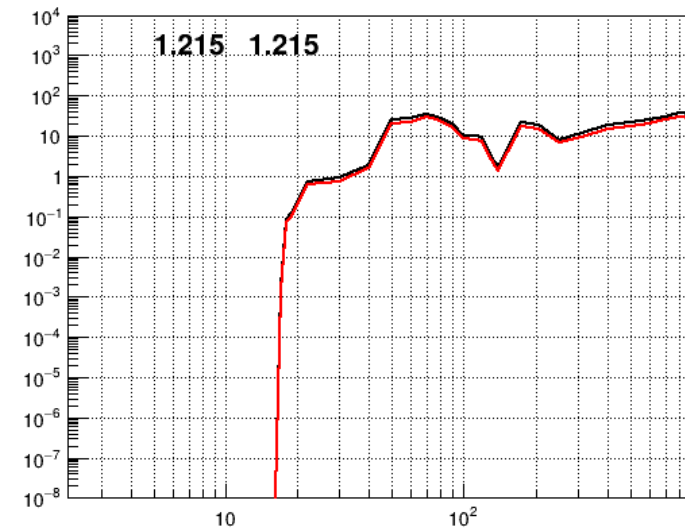
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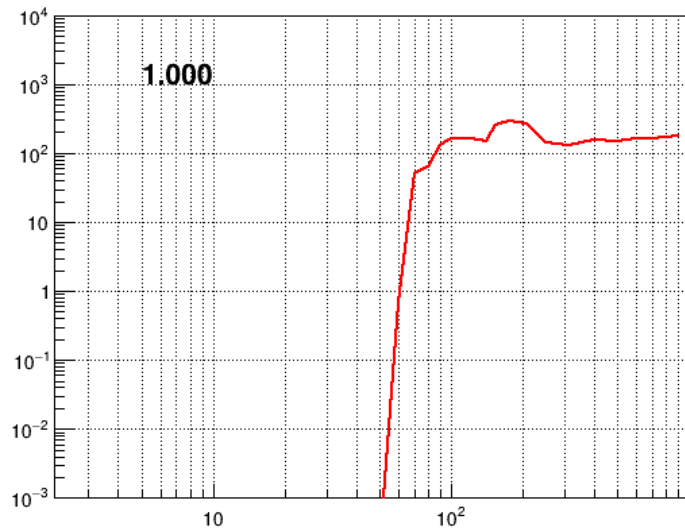
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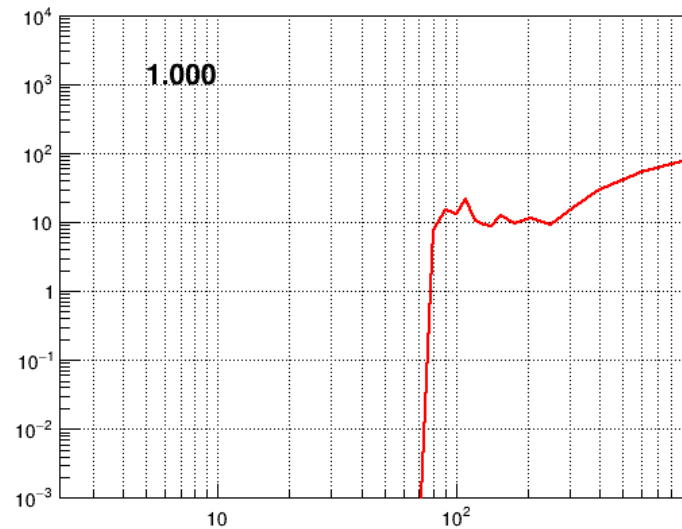
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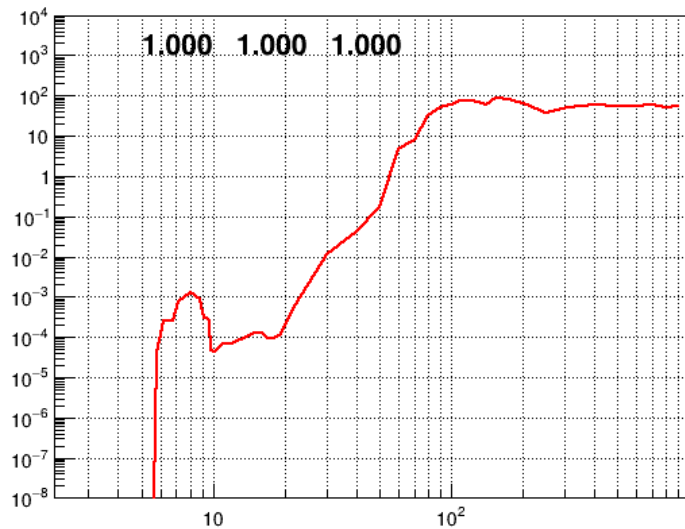


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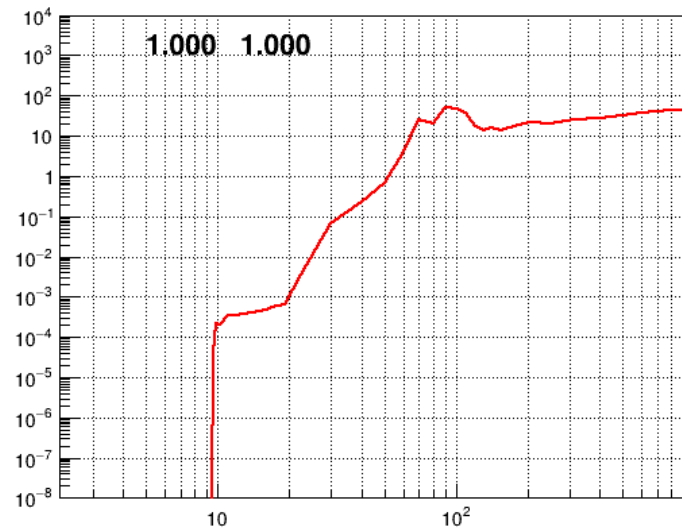
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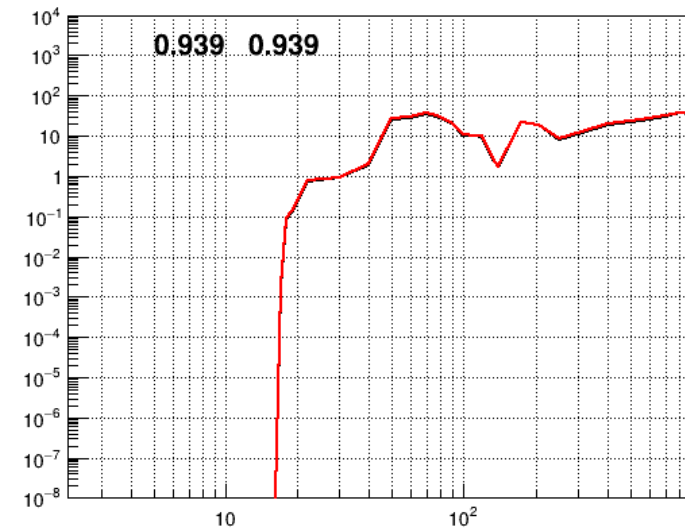
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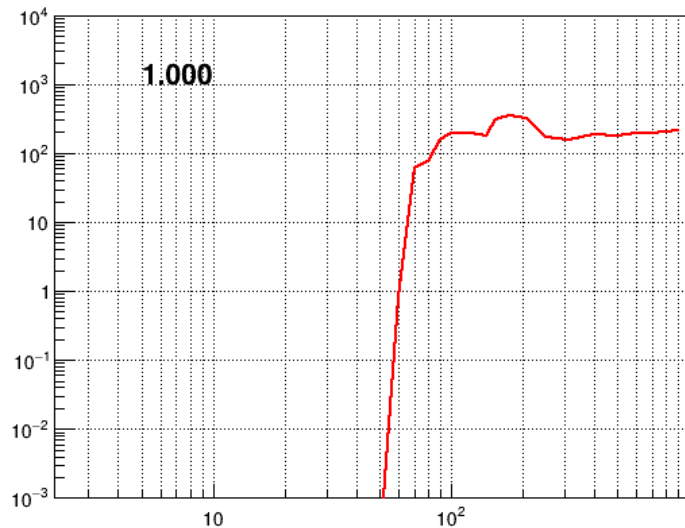
P2



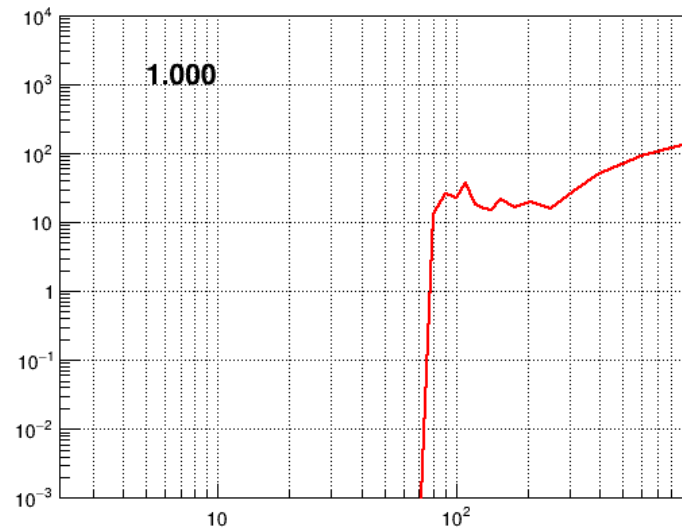
P3



P4



P5

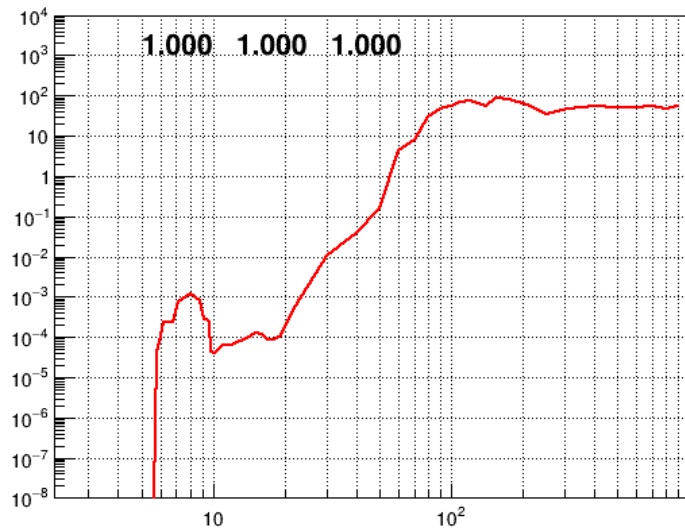


Nominal paper_drms/drm_2r_SVN58.dat

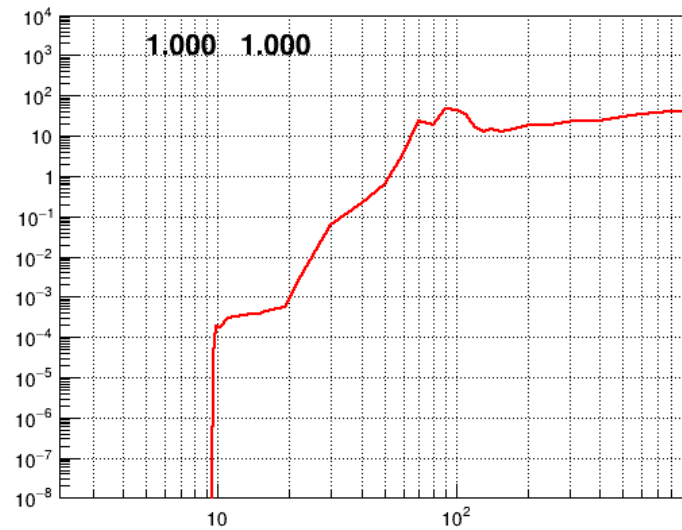
Updated response_files/drm_2r_SVN58.dat



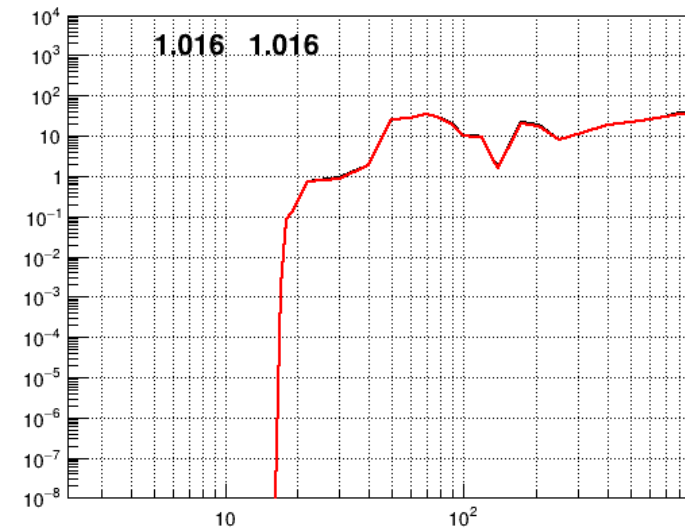
P1



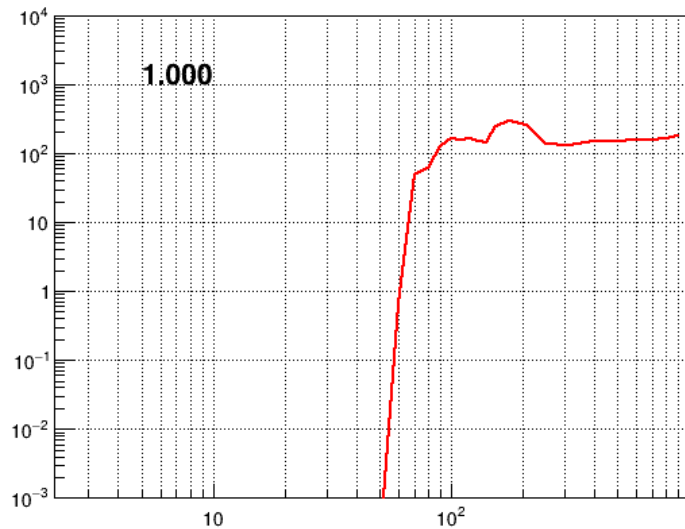
P2



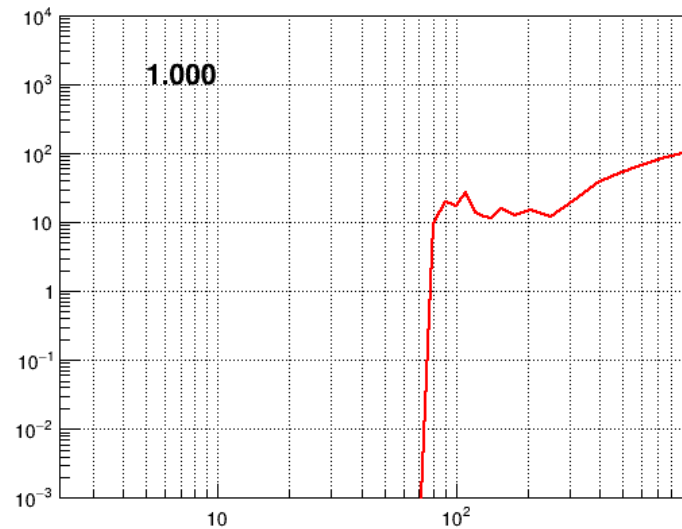
P3



P4



P5

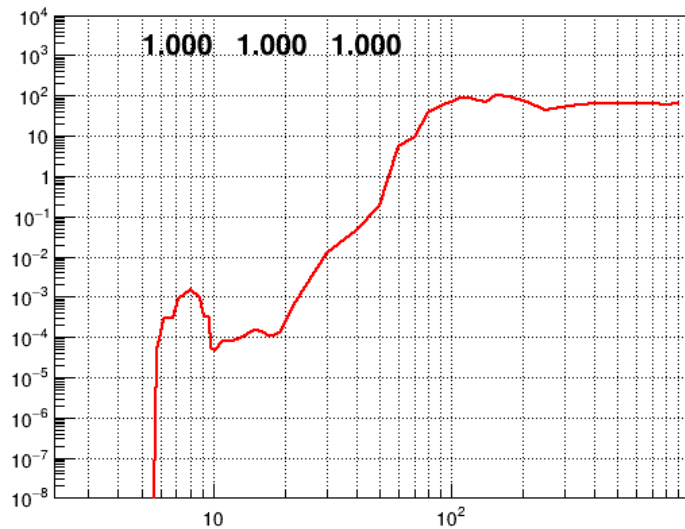


Nominal paper_drms/drm_2r_SVN59.dat

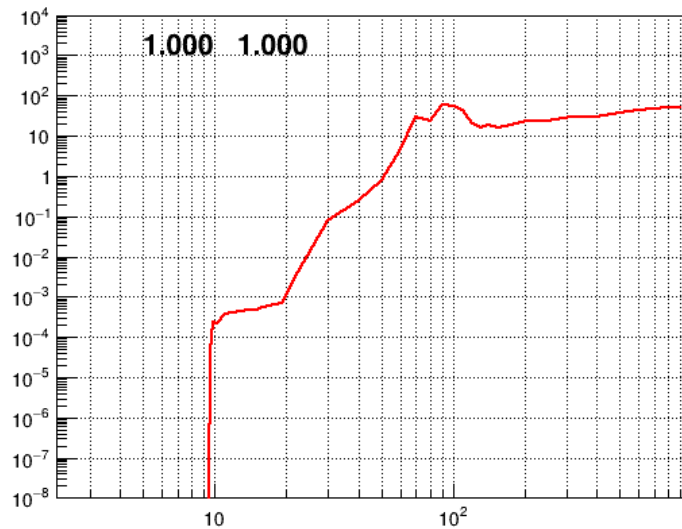
Updated response_files/drm_2r_SVN59.dat



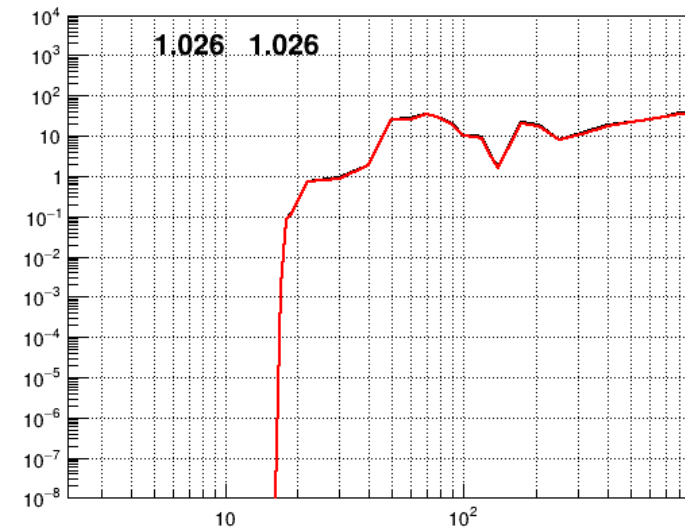
P1



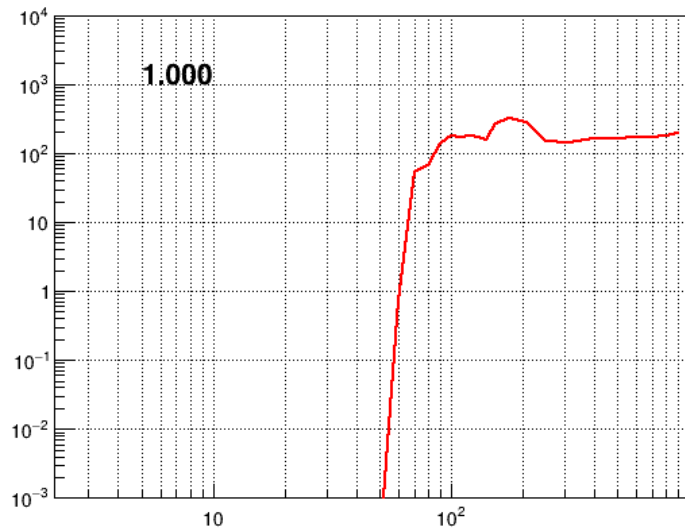
P2



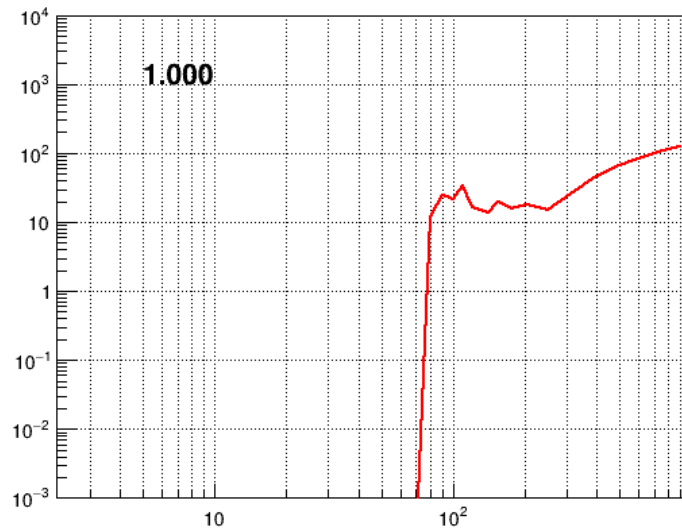
P3



P4



P5

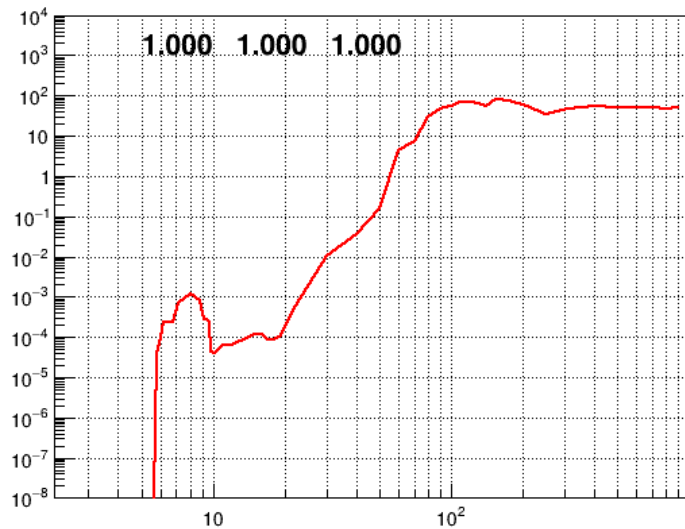


Nominal paper_drms/drm_2r_SVN60.dat

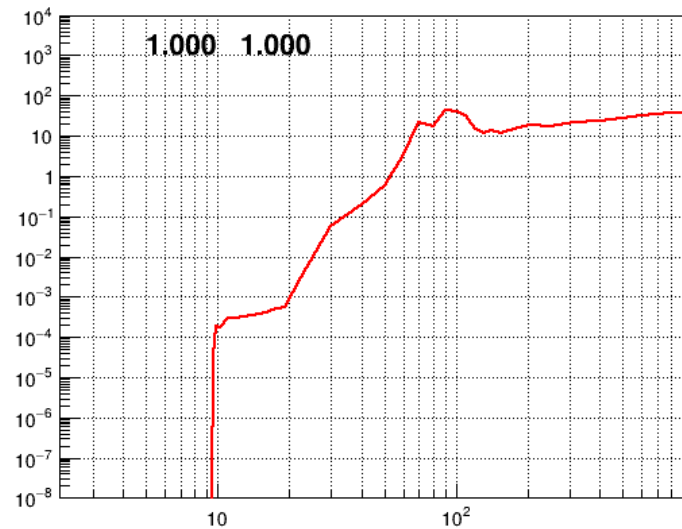
Updated response_files/drm_2r_SVN60.dat



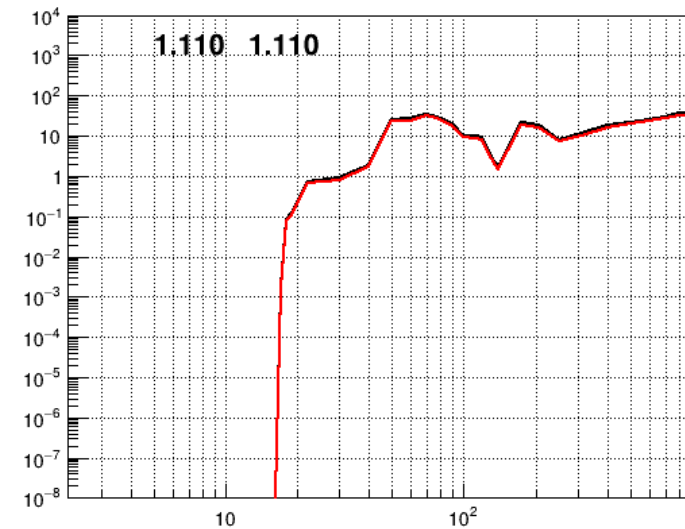
P1



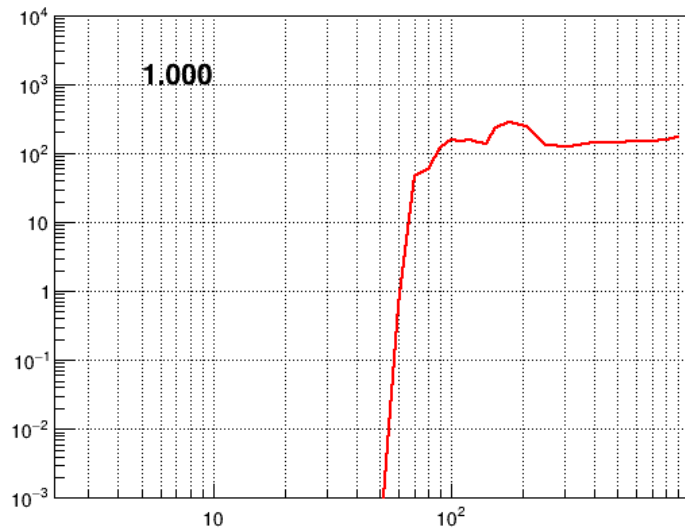
P2



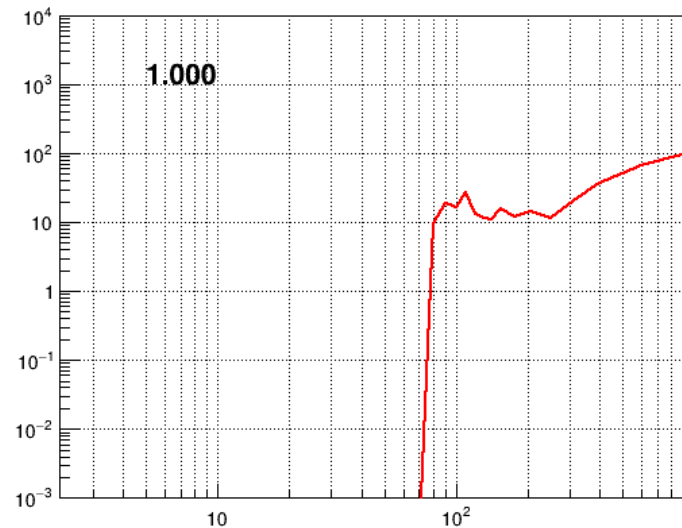
P3



P4



P5

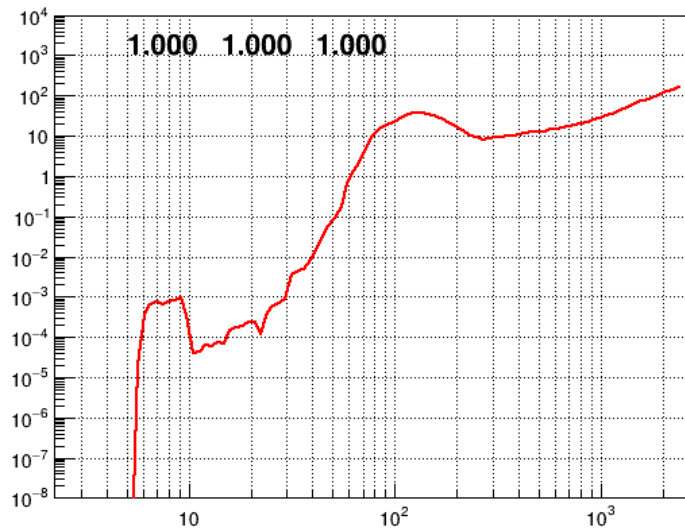


Nominal paper_drms/drm_2r_SVN61.dat

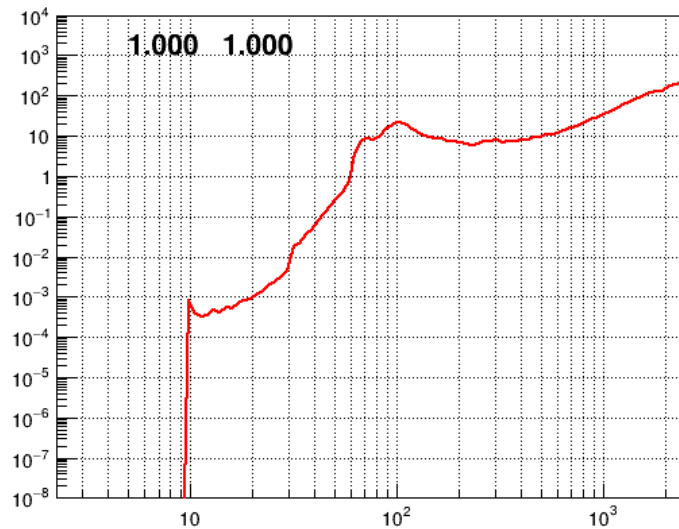
Updated response_files/drm_2r_SVN61.dat



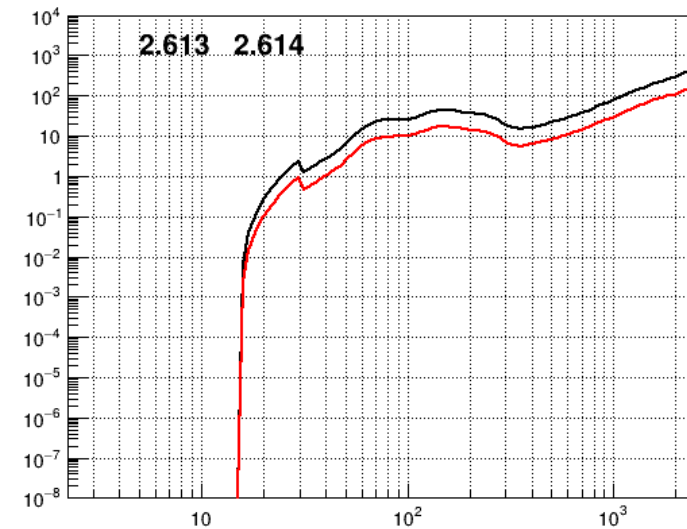
P1



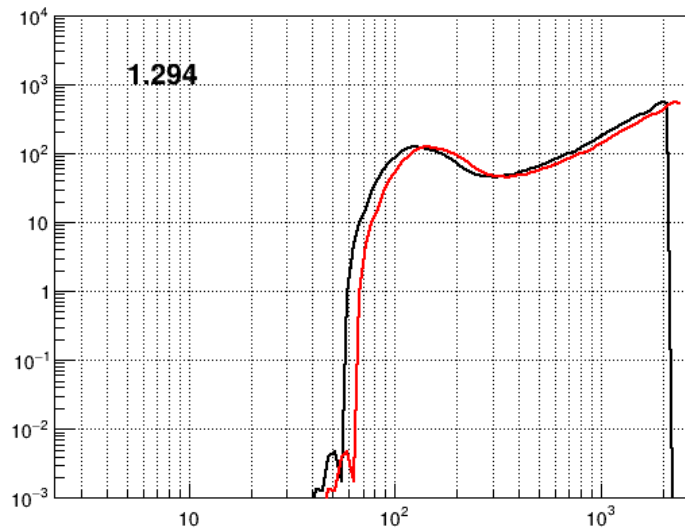
P2



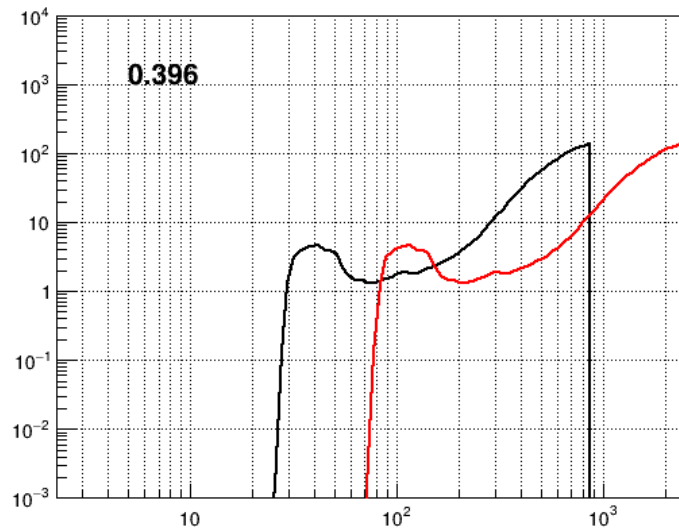
P3



P4



P5

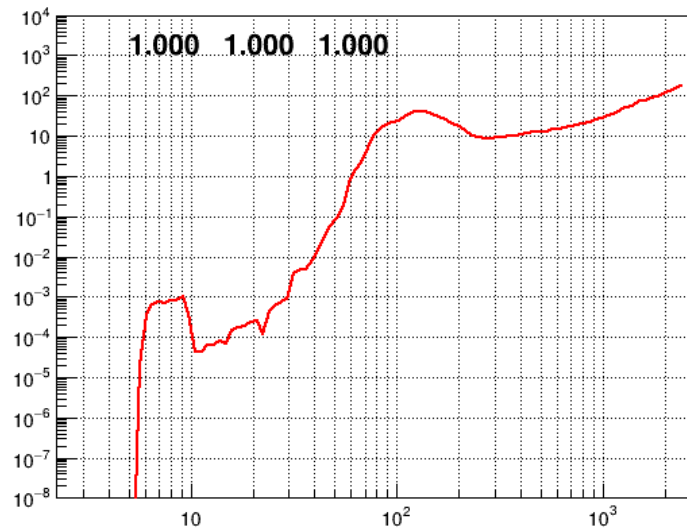


Nominal paper_drms/drm_2f_SVN62.dat

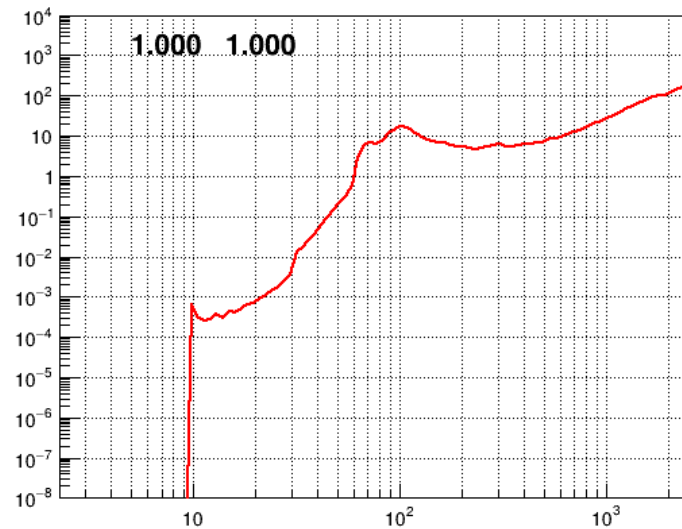
Updated response_files/drm_2f_SVN62.dat



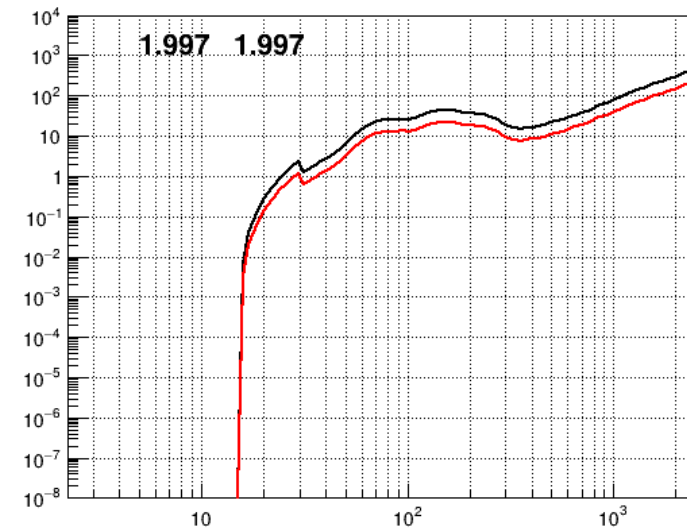
P1



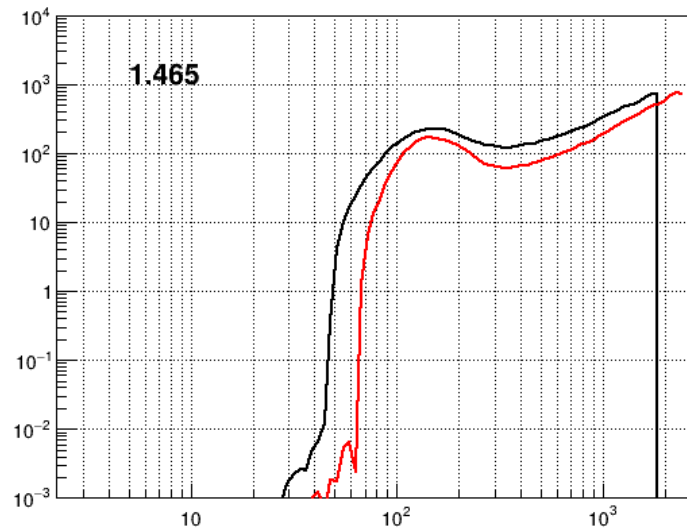
P2



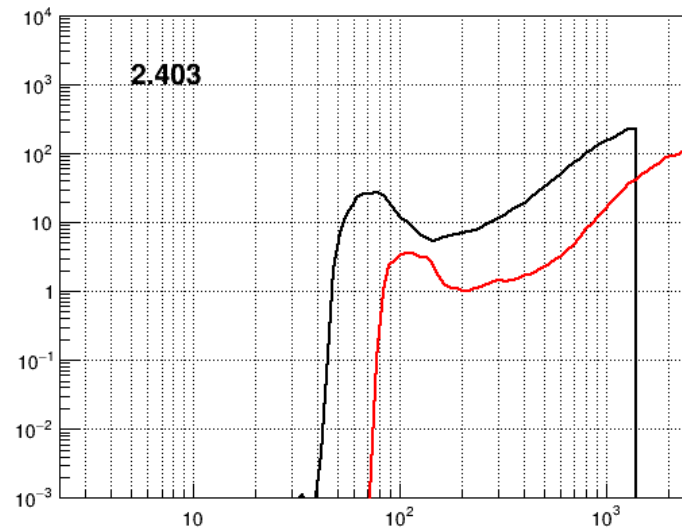
P3



P4



P5

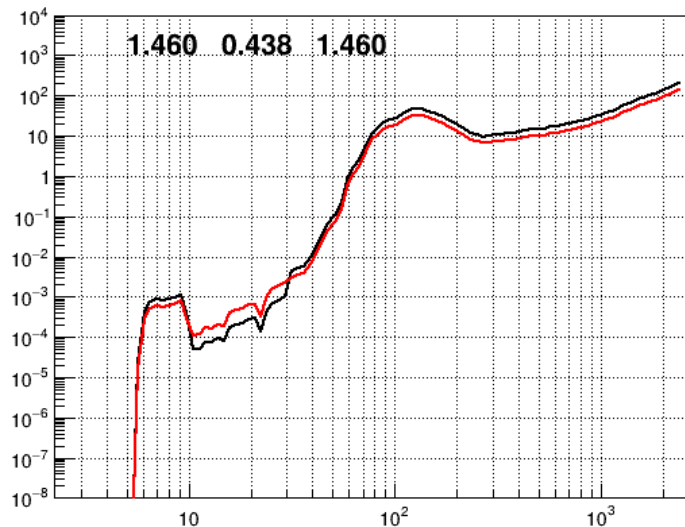


Nominal paper_drms/drm_2f_SVN63.dat

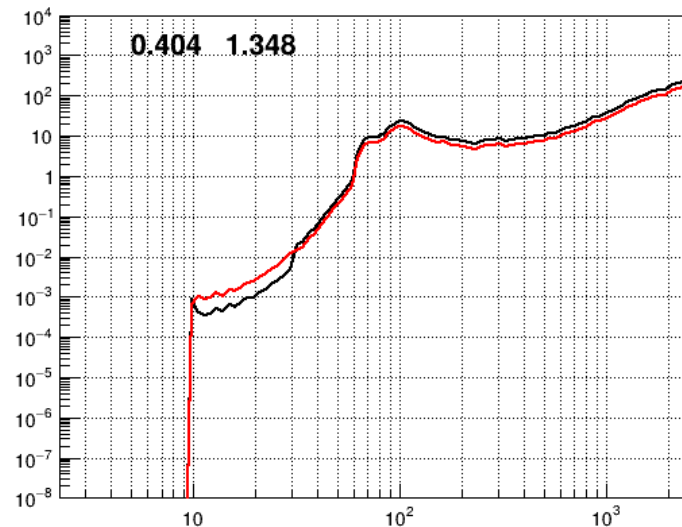
Updated response_files/drm_2f_SVN63.dat



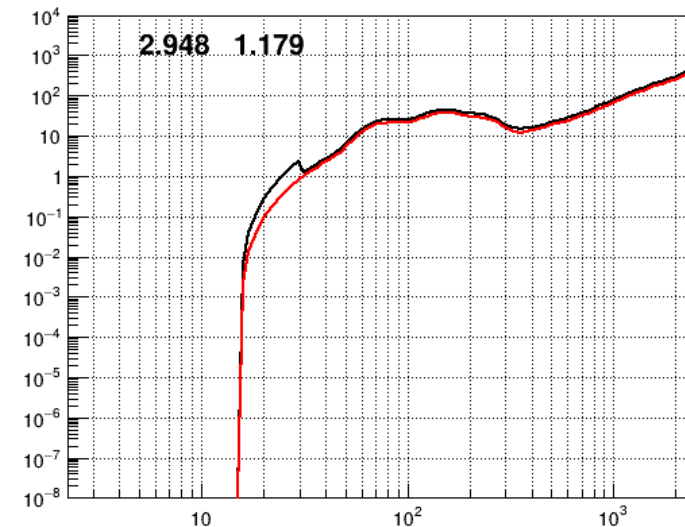
P1



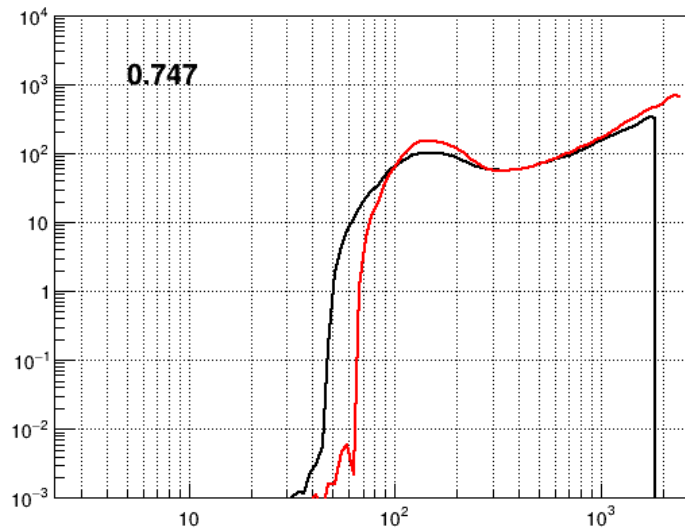
P2



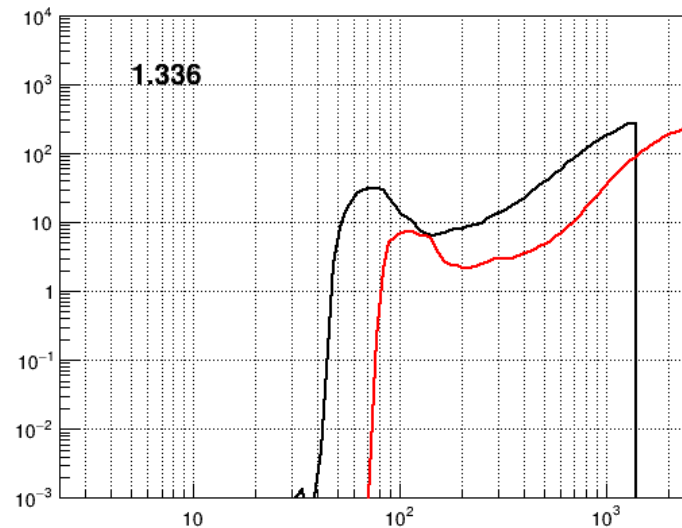
P3



P4



P5

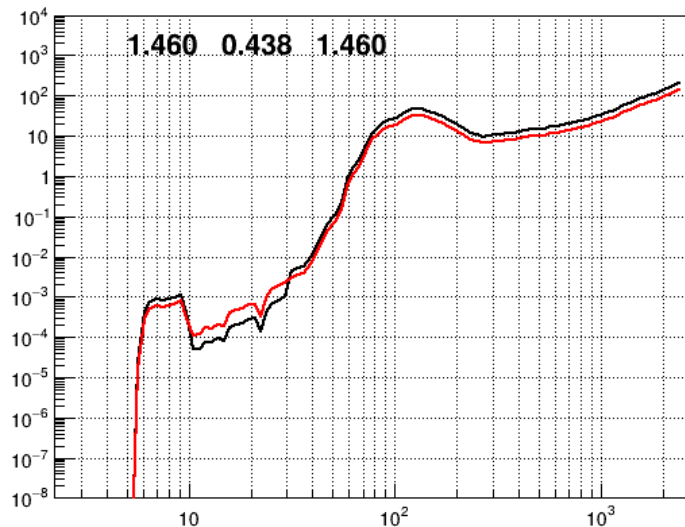


Nominal response_files/drm_2f_p_trial.dat

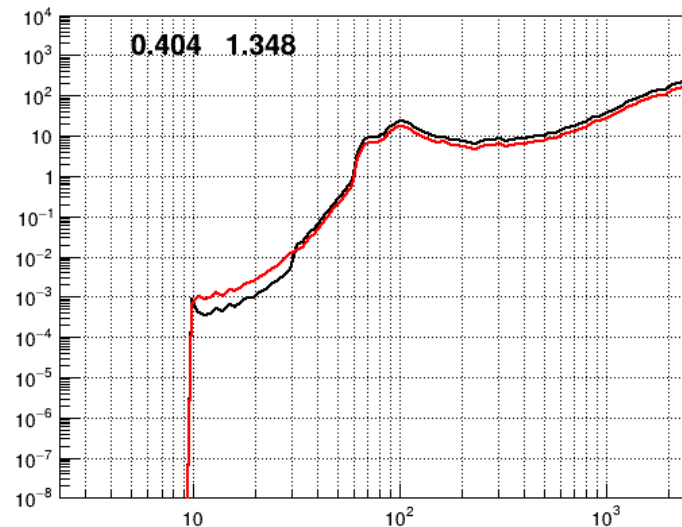
Updated response_files/drm_2f_SVN64.dat



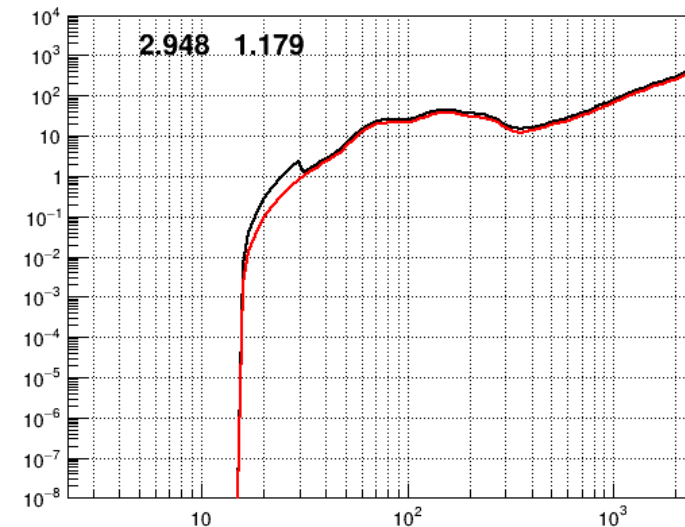
P1



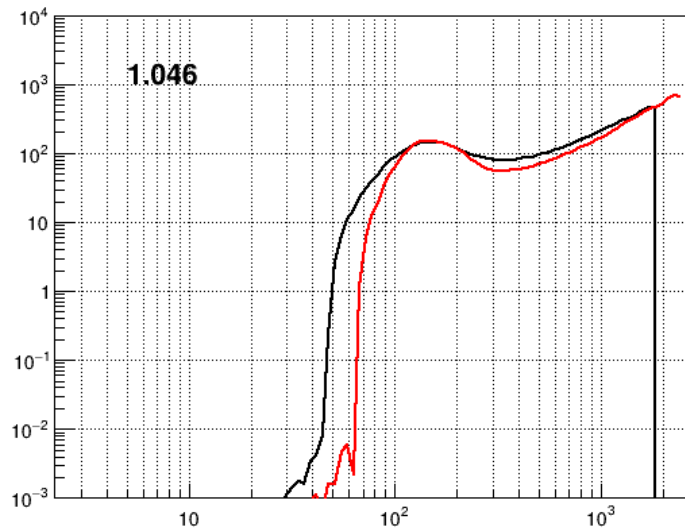
P2



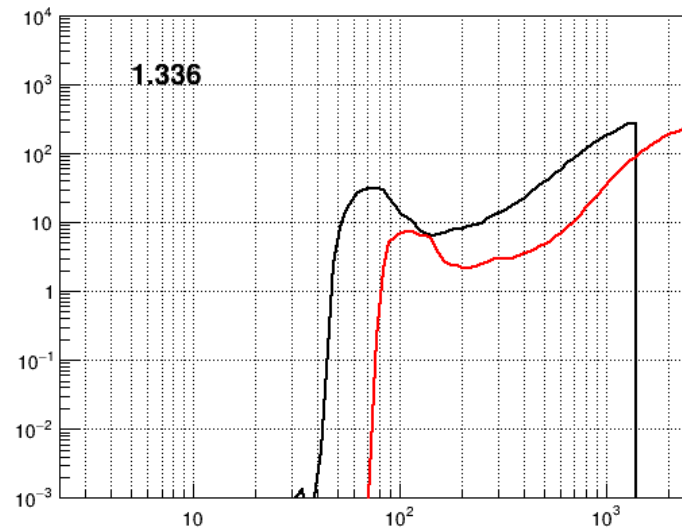
P3



P4



P5

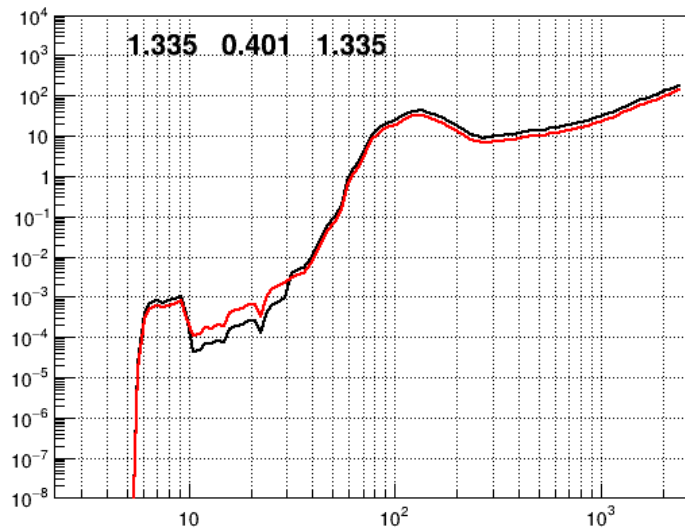


Nominal response_files/drm_2f_p_trial.dat

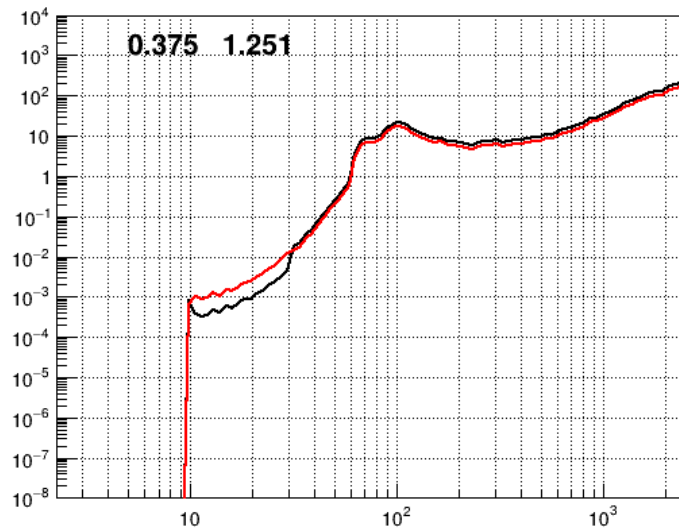
Updated response_files/drm_2f_SVN65.dat



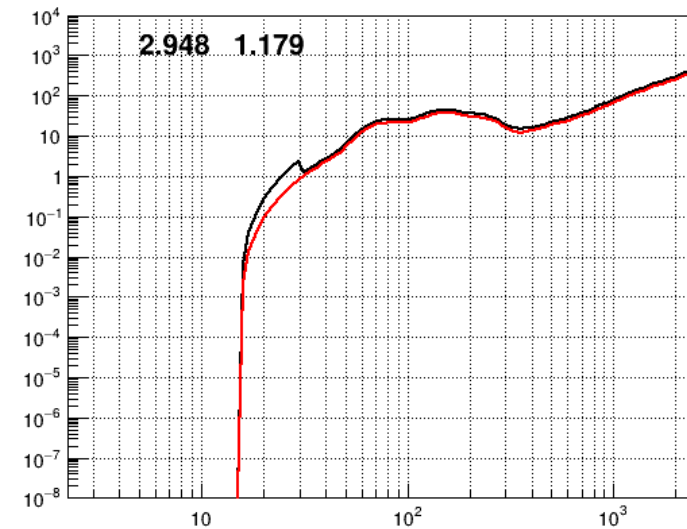
P1



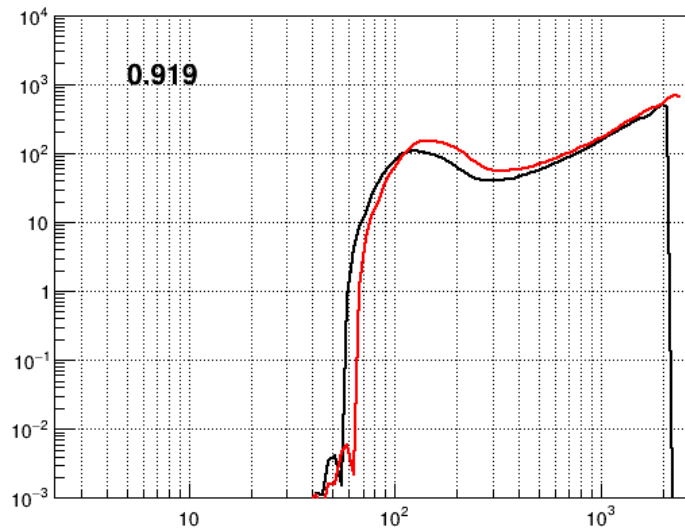
P2



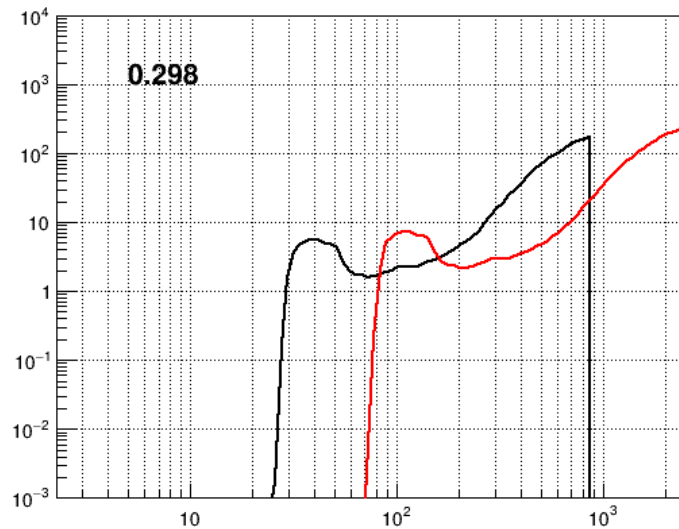
P3



P4



P5

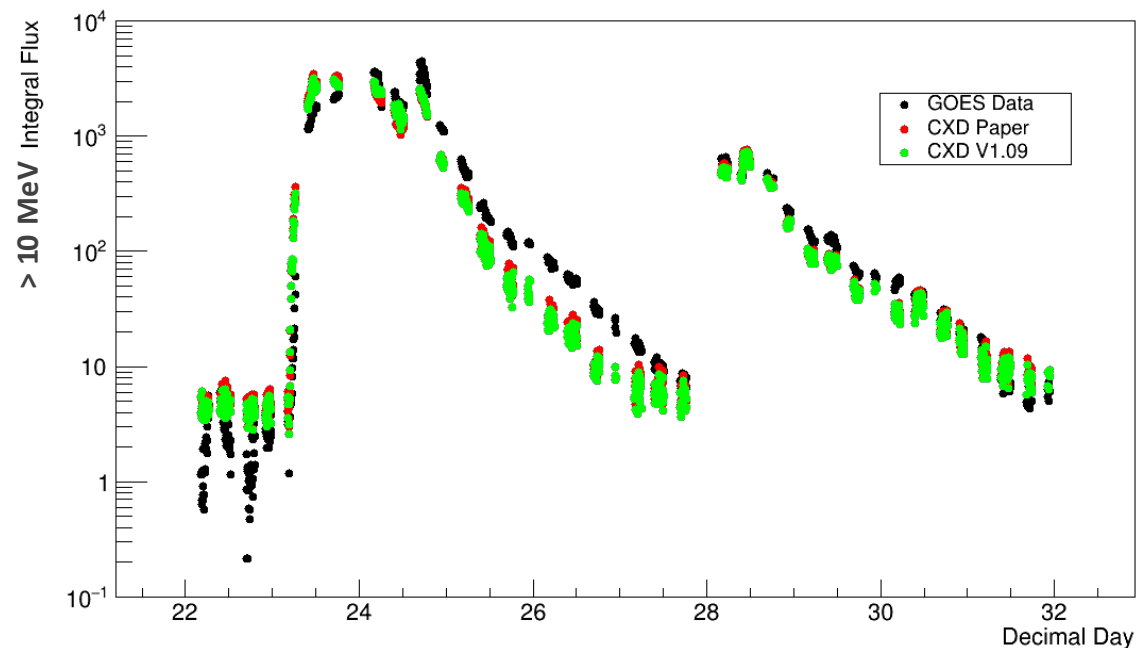
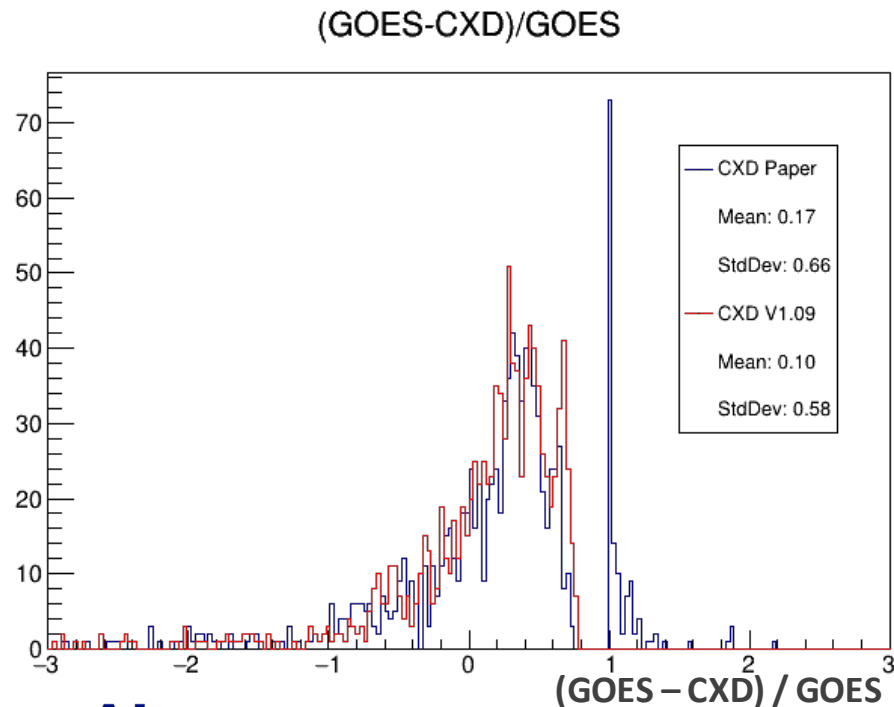


Nominal response_files/drm_2f_p_trial.dat

Updated response_files/drm_2f_SVN66.dat

Extent of the Damage – SVN 53 Flux (IIR)

- SVN53 arguably better with v1.09 compared with original cross-cal
 - Mean of % difference with GOES 0.1 vs 0.17 with smaller standard deviation
 - New fitting procedure and other updates with v1.09 might account for this



Extent of the Damage – SVN 62 Flux (IIF)

- SVN62 shows significant issues
- Lower flux consistent with significantly higher effective areas than correct DRM

